SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

DECEMBER 1901.

GENERAL PHYSICS.

2322. *Thermal Deformation of a Balance.* **T. Middel.** (Ann. d. Physik, 6. 1. pp. 214–216, Aug., 1901.)—The author replies to Felgentraeger [see Abstract No. 1622 (1901)], and admits that the unequal expansion of the beam and knife-edges does alter the sensitiveness of Krigar-Menzel's balance, but that the unequal expansion of the rolled and cast brass must be added in order to explain the whole of the difference observed. E. E. F.

2323. *Form of Rifle Bullets.* **E. Lampe.** (Deutsch. Phys. Gesell., Verh. 3. 10. pp. 119–124, 1901.)—According to Newton's theory, the resistance experienced by a body in motion through a resisting medium is to be calculated on the assumption that the resistance on each element of surface is proportional to the area, and to the square of the cosine of the angle between the normal to the element and the direction of motion. The writer refers to the works of Kneser, Armanini and August (in which Newton's theory is not unconditionally accepted). He then discusses mathematically by Newton's method the case of a truncated right cone of given height and given radii of its flat surfaces, and compares the results with August's tables. It is found that the resistance calculated by August for his assumed practical form of bullet does not materially differ from that of a surface of least resistance having the same front. In conclusion, he refers to Müller-Breslau's calculations of the resistance to navigable balloons, which agree fairly with Newton's law, but are irreconcilable with other laws, *e.g.*, that of Lössel. S. H. B.

2324. *Clustering of Gravitational Matter.* **Kelvin.** (Nature, 64. pp. 626–629, Oct. 24, 1901. Paper read before the British Association.)—It is assumed in this discourse, as in the previous paper [see Abstract No. 2078 (1901)], that the Newtonian law of attraction between masses of gravitational matter, known to hold accurately for certain interplanetary spaces, holds also throughout infinite interstellar space. It is the only law of which we have definite knowledge, and therefore is assumed to be universal.

Ether, according to this discourse, is matter, but is not gravitational matter, and the reason is given that, if it were gravitational, we should be compelled to assume its infinite incompressibility, which to the author appears improbable.

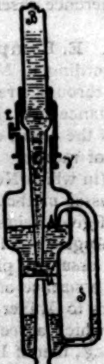
He considers it probable that there may be as much matter as a thousand million suns within a sphere of radius $8{\cdot}09 \times 10^{16}$ kilometres (that being the distance at which a star must be to have a parallax 0·001 of a second) because, given that they were uniformly distributed throughout such a spherical space, and at rest twenty-five millions of years ago, they would now have acquired, by their mutual attraction, some such velocities as the stars are now supposed to have.

Kelvin then compares the sunlight with that from the thousand million stars, supposing each star to have the same intrinsic brightness as the sun.

He works out the mathematical problem of the subsequent motion of a uniform sphere of matter of density ρ, given initially at rest, and discusses the question as to how this motion would be affected by ether.

If all the matter in the universe were, at a certain epoch, at rest, and more densely distributed in some regions than in others, there would be a tendency for the densities to become more unequal, solid bodies would ultimately form, and there would be collisions, giving rise, according to the author, to trains of waves in ether, carrying energy away to infinite space. The origin of meteoric stones is attributed to the cooling caused in this manner. S. H. B.

2325. *Laboratory Barometer with Automatic Zero Adjustment.* **B. Woringer.** (Zeitschr. Phys. Chem. 38. pp. 326–330, Sept. 17, 1901.)—The automatic zero adjustment of this instrument, shown in the figure, works as follows:—By means of a rubber bulb attached to the tube G, mercury is driven up the tube S into the vessel V until the surface of the liquid in V covers the point A. On releasing the pressure, mercury flows back again into the lower vessel until the opening at A just touches the mercury in the upper vessel. In this way the barometer tube B has a constant zero level. The author also gives a description of a vernier for reading barometers. T. H. P.



2326. *Theory of Elasticity.* **G. Bakker.** (Journ. de Physique, 10. pp. 558–563, Sept., 1901.)—The theorem is established that the increase of volume of a body of any shape, under the exclusive action of external forces applied to its surface, is proportional to the *virial* of these forces. This is then applied to the cases of a prism, a cylindrical shell, a spherical shell, a piezometer, and an electrified conductor. E. H. B.

2327. *Measurements of Gravity on the Italian Riviera.* **C. Aimonetti.** (Accad. Sci. Torino, Atti, 36. 13a. pp. 553–558, 1901.)—The author made measurements at Genoa, Savona, Albenga, and Sanremo. Details are given of the instruments used and the methods adopted. Comparing his results with values calculated from Helmert's formula—

$$G_0 = 9{\cdot}78046\,(1 + 0{\cdot}005302 \sin^2\phi - 0{\cdot}000007 \sin^2 2\phi)$$

the author finds the following differences: At Genoa − 0·00008; at Savona − 0·00055; at Albenga − 0·00029; at Sanremo + 0·00022. G. H. B.

2328. *Earthquake of April* 24, 1901. **L. Palazzo.** (Accad. Lincei, Atti, 10. pp. 351–354, 1901.)—An account is given of an earthquake, affecting Rome with considerable violence. Its origin was traced to a point at a depth of about half a kilometre under a sulphur spring at Cretone, and its cause to a subsidence of strata there. A. D.

2329. *Non-Pendular Apparatus in Seismometry.* **E. Oddone.** (N. Cimento, 1. pp. 195–201, 1901. Abstract from the Bull. Soc. Sism. Ital. 6, 1901.)—A description is given of apparatus for measuring both relative and absolute movement. It is of the nature of a hydraulic press, with one side of the large cylinder mobile and weighted: a shake alters the liquid pressure, and the displacement effect is magnified in the small cylinder, which is capillary and actuates a writing-point. The working is said to be satisfactory, and the instrument very sensitive. A. D.

2330. *Measurement of Atmospheric Pressure.* **G. Guglielmo.** (N. Cimento, 1. pp. 365–378, 1901. From R. Accad. dei Lincei, 10. series 5, No. 1.)—The author employs the principle of the areometer or cartesian diver for the measurement of atmospheric pressure and its variations. The advantage offered is that the ratio of glass to air may be so fixed as to eliminate temperature effects altogether, and the diver may be weighted so as to rise or sink at a certain pressure. By increasing the air space and the density of the liquid, the sensitiveness may be increased almost indefinitely. It is necessary, however, to prevent the absorption of the air by the liquid, and for this purpose the author either interposes a mercury column or a long capillary spiral tube. E. E. F.

REFERENCES.

2331. *Force Due to Continuous Impact.* **F. Slate.** (Phys. Rev. 12. pp. 363–365, June, 1901.)—The usual application of Newton's second law of motion is to cases in which the permanent factor is the mass, and the other factor, during any period, represents an aggregate of differential speed changes. With this is contrasted the case of a steady water-jet impinging on a plate. Here the permanent factor is change of speed, and the other factor represents an aggregate of differential masses. This case is discussed and the usual relation confirmed. E. H. B.

2332. *Apparatus for Illustrating Forced Vibrations.* **J. R. Benton.** (Phys. Rev. 12. pp. 377–378, June, 1901.)

2333. *Mercury Lifting Appliance.* **B. Woringer.** (Ann. d. Physik, 6. 1. pp. 211–213, Aug., 1901.)—The appliance described is for raising mercury automatically by means of a water vacuum-pump; it is convenient when cleaning mercury by allowing it to drop through acid, as it can be arranged to keep the mercury in continual circulation without any attention. G. H. B.

2334. *Struts with Transverse Loads.* **H. E. Wimperis.** (Cambridge Phil. Soc., Proc. 11. pp. 191–199, Aug. 10, 1901.)—Some experiments on the collapse of struts, when subjected to a concentrated transverse load in addition to the longitudinal compression. H. R. C.

2335. *Microseismometrograph.* **G. Agamennone.** (Accad. Lincei, Atti, 10. pp. 291–299, 1901.)—The author completes his description of the three-component instrument [see Abstract No. 2405 (1900)] by an account of the arrangement for recording the vertical component, founded on Ewing's work of 1881 (Trans. Seism. Soc. Japan, vol. 3, p. 140). A. D.

2336. *Density of the Solar Nebula.* **A. S. Young.** (Astrophys. Journ. 13. pp. 338–343, June, 1901.)—The authoress attempts to find a satisfactory equation representing the conditions obtaining in the primary nebula from which the solar system has been evolved. Various methods are described involving several assumptions, but it is concluded that "it seems probable that the density of the solar nebula was irregular." C. P. B.

2337. *Formation of Meteorites, Comets, and Nebulæ.* **T. C. Chamberlin.** (Astrophys. Journ. 14. pp. 17–40, July, 1901.)—This paper consists of an elaborate extension of the discussion of "Roche's limit" to the formation of celestial bodies, many of the conclusions agreeing closely with the actual photographed forms of known objects. C. P. B.

2338. *Exploration of the Higher Atmosphere.* (Archiv Post Tele. 17. pp. 561–565, Sept., 1901. Abstract of a paper, read by **Assmann,** on the work of the Aeronautical Observatory of the Royal Meteorological Institute at Tegel, near Berlin.)—Unmanned balloons, kite or captive balloons (combined with the apparatus of Parseval and Siegsfeld, a bag, open at the lower end and not charged, to be inflated by the wind), and kites are employed. The paper also reproduces the police notices concerning the treatment of balloons or kites and their registering instruments when found. H. B.

2339. *Report on the Observatory Department of the National Physical Laboratory for the Year ending Dec.* 31, 1900. (Roy. Soc., Proc. 68. pp. 421–453, Sept. 12, 1901.)—This work is considered under the following headings: I. Magnetic Observations. II. Meteorological Observations. III. Seismological Observations. IV. Experiments and Researches. V. Verification of Instruments. VI. Rating of Watches and Chronometers. VII. Miscellaneous.

2340. *Objects having Peculiar Spectra.* **E. C. Pickering.** (Astrophys. Journ. 14. pp. 144–146, Sept., 1901. Harvard College Observatory Circular No. 60.)—This paper gives a list of stars having peculiar spectra, found by Mrs. Fleming from an examination of the Draper Memorial photographs, with notes on the nature of the peculiarities.

2341. *The Atomic Theory.* **A. W. Rücker.** (Electrician, 47. pp. 801–804, Sept. 13; and 839–842, Sept. 20, 1901.)—Presidential address delivered at Glasgow, Sept. 11, 1901.

LIGHT.

2342. *Proofs of Refractometer Formulæ.* **A. Cornu.** (Comptes Rendus, 133. pp. 463–469, Sept. 16, 1901.)—The author here gives the mathematical proofs of the formulæ contained in a preceding paper on the determination of the optical constants of biaxial crystals, by a method depending on total reflection from the face of the crystal, when it is placed in a more refracting medium. [See Abstract No. 1868 (1901).] The first group of formulæ are purely geometrical, and give the angles α, β, γ, which the normal to the crystal face makes with the three principal axes. By spherical trigonometry, triangles are obtained connecting the unknown angles α, β, γ with the observed azimuths of three planes of reflection, giving maximum or minimum values for the angle of total reflection. Difficulties connected with the uncertainty of observations at a maximum or minimum, and with ambiguities in solution of the triangles are discussed. The second group of formulæ involve the refractive indices. Their demonstration resolves itself mainly into a calculation of the direction cosines of various lines, with a view to determining the angles between them. A. E.

2343. *Visual Sensation.* **C. L. Morgan.** (Roy. Soc., Proc. 68. pp. 459–474, Sept. 12, 1901.)—This is a Croonian Lecture, in which the author gives an account of his studies in visual sensation. It is well known that a series of equal increments of stimulus does not produce a similar series of equal increments in sensation. This may be illustrated by means of a rotating disc. When the physical luminosity of a surface is the arithmetical mean between that of a white and a black surface, the brightness, or sensation-luminosity, is far removed from the arithmetical mean between that due to white and that produced by black. With a disc made up of successive rings shading off from black to white, effects of contrast come into play, but these can be allowed for. A series of rings may be obtained which do afford approximately equal steps from black to white, of which any intervening ring appears to be of an intensity which is the arithmetical mean between its neighbours on either side. This may be done by means of slit discs on Maxwell's method, giving sectors which slide over each other so as to alter the relative proportions of the white and black. First a mid-grey may be found, which appears to give a half-way sensation between black and white; then other greys, which appear to be arithmetical means between the mid-grey and black on the one hand, and on the other hand between the mid-grey and white. Thus, by a series of careful adjustments, rings may be obtained which enable the eye to pass from black to white by steps which are of approximately equal value for sensation. Using this scale or ladder from black to white, the black (a dull black surface coated with black enamel) may be termed the zero of an arbitrary scale, and may be assumed to be a very dark grey, and taken as the zero of stimulus, and also the zero of sensation. At the other end of the scale the white (white paper) affords an arbitrarily selected luminosity under given conditions of illumination, and may be called 100 per cent. of stimulus, corresponding to 100 per cent. of sensation. The experimental results obtained, expressed in percentages, are as follows :—

Sensation	0	25	50	75	100
Stimulus	0	6·5	20	47	100

While the sensations are in arithmetical progression, there is at first sight no very definite series in the stimuli. But putting down the *increments* of sensation and of stimulus, the figures are :—

Sensation............	0	+ 25	+ 25	+ 25	+ 25 = 100
Stimulus	0	+ 6·5	+ 13·5	+ 27	+ 53 = 100

Here the stimulus increments are nearly in geometrical progression, and, as a provisional and empirical generalisation, it may be said that equal increments of sensation require increments of stimulus in geometrical progression.

Hence other points may be interpolated between those obtained by observation, and through them a smoothed curve drawn. The author finds that, for his eye, the mid-point between black and white corresponds to 12 per cent. of white stimulus. When the illumination is reduced to one-half its original value the mid-sensation becomes 41·5 per cent., and requires 8 per cent. of stimulus. Hence, to produce a mid-sensation between the black and the reduced value of the white, an additional 2 per cent. of stimulus is required.

Experiments on colours shading off into black, and white shading evenly into colour, and also cases of the shading of one colour into another, were carried out, and these confirmed the previous result that equal increments of sensation require increments of stimulus in geometrical progression.

In conclusion, the author refers to the relation which the empirical scale of sensation may hold to an absolute scale based on certain assumptions.

J. J. S.

2344. *Negative After-Images and Colour Vision.* **S. Bidwell.** (Roy. Soc., Proc. 68. pp. 262–265, June 24, 1901. Abstract in Nature, 64. pp. 216–218, June 27, 1901.)—The paper deals with the "pulsative after-images" produced by a recurring series of short flashes, which were described by the author in a former communication (Roy. Soc. Proc. 61. p. 268 ; Nature, 56. p. 128), and which differ considerably from the ordinary negative after-images seen on a white ground after prolonged gazing at a coloured object. The present experiments were made with pure spectrum colours. A round colour patch is flashed on a screen for $\frac{1}{40}$ second, and then, in the same place, a patch of white light for $\frac{3}{40}$ second. Then, after a dark interval of $\frac{1}{10}$ second, the colour-patch is repeated, and so on in regular succession. A form of W. Abney's colour-patch apparatus is used, intermittency being secured by a rotating disc, with windows, placed in the paths of the beams. The true tint of the colour patch is not seen at all, but its approximate complementary. Thus, when the patch is really green, the appearance is that of a purple patch surrounded by an annulus of flickering white. The pulsative after-images of red, purple, and orange patches are all of nearly the same bluish-green tint, while those of yellow and blue are generally pink. If a complete spectrum be projected on a screen, the pulsative images of red and green are far more intense than those of yellow, blue and violet. If the white patch be replaced by an annulus of smaller diameter than the coloured patch, the annulus appears to be bordered on either edge by a narrow black ring, showing that white light has the power of restraining the visual sense-organs adjacent to those upon which it actually falls from responding to the green stimulus. It would seem to follow *a fortiori* that the sense organs directly acted on must be similarly incapacitated. In the formation of the pulsative image, then, it is not a case of the green sensation being produced for a moment, and then swamped by the more powerful one; it never actually comes into existence at all. A possible explanation is that the latent period for a colour sensation is very much greater than for white, say $\frac{1}{10}$ second, as compared with, at most, $\frac{1}{500}$ second. Thus, if in a dark room, a green flash is admitted to the eye for $\frac{1}{10}$ second, it is not seen till the green ray which excited it has been shut off. What is actually perceived is, in fact, a positive after-image. But if a bright white surface is presented to the eye immediately after the green stimulus, the after-image formed will not be positive but negative. In some cases it is better to view the pulsative image directly with an eye-piece, instead of receiving it upon a screen. The following experiment proves that phenomena of simultaneous contrast are not always due to mental judgment. If a purple pulsative image is produced from a bright-green colour patch, the whole of a white-light field four times as wide as the colour patch appears to be purple. This cannot result from mental contrast with green, since no green at all is consciously perceived. Some account is given of another class of phenomena. If the image of a white object be suddenly formed on the retina after a period of darkness, it appears surrounded by a narrow red border. It is found that pulsative images of spectral red, orange, and yellow produce the red border, the effect stopping short at the beginning of the greenish yellow. Blue and green produce a blue-green border. Generally the experiments establish nothing decisively in favour of either Young's or Hering's theory, and some of them seem to indicate that neither theory is tenable in its present form. A. E.

2345. *Anomalous Dispersion of Cyanin.* **A. Pflüger.** (Phil. Mag. 2. pp. 317–318, Sept., 1901.)—A reply to passages in recent papers by Wood. [See Abstracts Nos. 661 (1899), 791 and 1686 (1901).] A strong absorption band was found by Wood in the ultra-violet, of which Pflüger's photographs show no trace. The latter attributes the discrepancy to difference of chemical constitution in the specimens of cyanin used. He defends his prisms (wrongly described as Wernicke's) against Wood's criticisms, and maintains that Wood's measurements are not really more accurate than his own. The principal difficulty lies, he says, not in making a prism with perfect enough faces, but in the broadening of the image of the slit in the region of the absorption-band, owing to the decline of the dispersion-curve and the narrowness of the transparent part of the prisms. A. E.

2346. *Colour Solutions for Orthochromatic Plates.* (Scientific American, 85. p. 84, Aug. 10, 1901.)—Different colour solutions, mostly of the eosine group, were tested to find their relative sensitising powers. The plates sensitised by them were exposed to red light. Erythrosene was found to have twice the sensitising power of any other solution tried. Directions for sensitising are given. G. H. B.

2347. *The Spectrum of Cyanogen.* **E. C. C. Baly** and **H. W. Syers.** (Phil. Mag. 2. pp. 386–391, Oct., 1901. Paper read before the Physical Society of London, June 28, 1901.)—Smithells pointed out [Abstract No. 1272 (1901)] the desirability of observing the vacuum-tube spectra of cyanogen, since if

the carbon spectra were absent it would support his theory that the "carbon-oxide" spectrum is due to CO_2 and the Swan spectrum to CO, while the line spectrum belongs to the element carbon. Baly, in 1898 (ibid. xxxv., 200), in attributing certain spectra to H and CO_2, had been criticised by Kayser (Handbuch d. Spectroscop., 198), from the general view that CO_2 had no spectrum. It was found, however, that in mixtures of H and CO the Swan spectrum was at once changed into that of "carbon-oxide," and that it could only be separately obtained with very pure CO, leading to the inference that the spectra were those of CO and CO_2 respectively. A very small quantity of CO_2 gives a very decided spectrum, and can easily mask that of CO, while CO itself is so readily changed into CO_2 that it shows none, or very little, of the Swan spectrum, but only that of "carbon-oxide." When perfectly pure CO, from formic acid and H_2SO_4, is used, and all gases are removed from the glass and electrodes by heating and exhaustion, the Swan spectrum only is obtained. Under certain circumstances CO deposits carbon, and the "carbon-oxide" spectrum then at once appears, a result which also occurs if a trace of oxygen be admitted, both facts strongly supporting Smithells' opinion. The authors purified cyanogen by freezing, and allowed it to slowly evaporate into the vacuum-tube, using an apparatus which is figured. On account of the discharge producing a brown coating of paracyanogen, it was necessary to examine the tube "end on." After repeatedly admitting and pumping out the gas, a very beautiful spectrum of pure cyanogen, differing from the flame-spectrum, was obtained. It showed a series of flutings through the red and yellow, wider than the nitrogen bands, and without the break in the orange. These experiments prove that the Swan spectrum is not produced by a carbon compound which does not contain oxygen; that it is only produced by carbon monoxide; and that the "carbon-oxide" spectrum belongs to carbon dioxide. The research was made in the Spectroscopic Laboratory of University College, London.
S. R.

2348. *Phosphorescent Glow in Gases.* **J. B. B. Burke.** (Phil. Mag. 1. pp. 342–356, and 455–464, 1901.)—Between certain limits of pressure, which vary for different gases, a brilliant phosphorescence follows the passage of the ring discharge in an electrodeless vacuum-tube. This glow may last for one or two minutes, and takes place in the gas, not being an electrostatic effect on the glass. The after-glow is exhibited for air bulbs if the pressure is between 0·7 mm. and 0·02 mm., and is brightest at about 0·1 mm. In one of the experiments the external discharge takes place round a bulb at the end of a long tube, 5 cm. diam., connected with a McLeod gauge. When the discharge is produced in the bulb, the glow passes down the long tube at the rate of about 2 m. per sec., the rate being smaller for narrower tubes. It is "inferred that the phosphorescence consists of glowing particles or molecules which do not carry an electrical charge, which are not destroyed or broken up by an e.m.f. sufficiently small not to produce a discharge in the gas, and which are not created by the recombination of ions along the tube, but are particles or molecules that are produced in the bulb by the passage of the ring discharge and make their way down quite independently of the electrical condition of the tube." The phosphorescence of gases appears to be due to the presence of foreign bodies, and the presence of oxygen seems a necessary condition for the glow, although not in itself a sufficient one. Further experiments show that (1) "the glow conducts as it passes through the gas"; (2) "the destructive effect of sparks on the glow is due to kathode rays"; (3) "there is an analogy between the glow and thermoluminescence"; (4) "the phosphorescent particles appear to consist of large molecular groups formed by the spark, and which may continue in existence for some time (notwithstanding the bombardment from the molecules of the gas) in consequence of the repulsion which they must exert on molecules that approach them."

G. E. A.

2349. *Secondary Rays.* **E. Dorn.** (Archives Néerlandaises, 5. pp. 595–608, 1900.)—Sagnac has shown that certain of the rays given off when Röntgen rays fall on heavy metals are absorbed by a layer of air 0·1 mm. thick, thus exhibiting a similarity to the extreme ultra-violet rays photographed by V. Schumann. Dorn, by passing the rays from a powerful tube into an evacuated chamber, produces secondary rays on a tilted lead plate. These rays pass upwards through slits in lead plates to a photographic plate, and it is shown that they are absorbed by fluorite and quartz, but are transmitted easily by thin aluminium. The rays are not regularly reflected, and the existence of a diffuse tertiary radiation points to a connection with kathode or Röntgen rays. By using a magnet it was found that part of the secondary beam was deflected and part unaffected. The electrical screening was sufficient to prevent a direct production of kathode rays inside the apparatus, and it was also proved that there were no kathode rays in the direct beam from the tube. Curie and Sagnac have since verified that the deviable secondary rays are only produced by Röntgen rays impinging on heavy metals. From measurements made, the value 864 is found for Lenard's double integral, and the velocity of the deviated rays is calculated from the formula $v = \frac{e}{m} \cdot \frac{864}{s}$, where s is the deviation. Taking Lenard's and Simon's values for $\frac{e}{m}$, values of v are found which vary between $1{\cdot}8 \times 10^9$ and $8{\cdot}5 \times 10^9$ cm./sec. The high velocity of the negative particles is probably due to the violence of the impulses.

G. E. A.

2350. *Uranium Radiation.* **H. Becquerel.** (International Physical Congress at Paris, Report, 3. pp. 47–78, 1900.)—The report gives a good summary of the present knowledge of the above subject. It treats of the photographic and electric methods of observation, and the use of a uranium sphere is mentioned as a new method of obtaining the potential of a point in space, the rate of fall of potential of the sphere when connected to a condenser of known capacity being expressed by $\frac{\partial V}{\partial t}\left(a + \frac{b}{V}\right) = -1$, where a and b are constants depending on the capacity of the system. Other effects, such as phosphorescence and magnetic and electrostatic deviation, are described. The report does not confine itself to the radiation from uranium.

G. E. A.

2351. *The Nature of Röntgen Rays.* **J. Semenow.** (Comptes Rendus, 133. pp. 217–219, July 22, 1901.)—In a bianodic tube with platinum antikathode, the antikathode emits Röntgen rays by both faces (anterior and posterior) in the same way, but the intensity of radiation from the anterior face is much the greater of the two. The antikathode only emits rays if it be electrically charged : if put to earth it emits none. The rays coming directly from the kathode have an intensity much inferior to that of the posterior antikathodic radiation, and are in this respect comparable to the radiations from the walls of the tube. Experiments are then described upon the unipolar production of Röntgen rays. The three electrodes of a bianodic tube were connected together, and with either of the poles of a focus tube in action: the bianodic tube acted quite in its ordinary manner, but much more feebly, always provided that there was a Crookes tube in the secondary circuit of the induction coil. Any conductor in the neighbourhood of a Crookes tube becomes a source of "secondary" rays; and this induced radiation is more powerful the higher the charge on the conductor. Conclusions:—Röntgen rays represent the direction of propagation of electric vibrations through the ether, which vibrations are communicated to all bodies impinged upon; and when these bodies are insulated, and protected from loss by convection, they lose their charge by radiation. A. D.

2352. *Effect of Becquerel Rays on Air.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 2. pp. 590–598, July 6, 1901.)—Rutherford has found that air passed over thoria makes other substances upon which it impinges radio-active, particularly if they be negatively charged. The Becquerel rays, then artificially induced, may be recognised by their making the air conductive, through ionisation. The authors investigated as to whether air not passed over thoria or other analogous substances would produce the same effect to any extent. They find that it does so in presence of a negative charge, and that the air probably contains a radio-active gas. Wherever there is a steep atmospheric potential-gradient leading to a dense negative charge on the earth (*e.g.*, on mountain peaks) there must be an increase in the conductivity of the air. Certain anomalies in electrical dispersion in closed rooms, when bodies are introduced which have been long exposed to electrified air, now find their explanation in the conclusion that natural atmospheric air in contact with negatively charged bodies of any kind makes these bodies radio-active.

A. D.

REFERENCE.

2353. *Röntgenised Air.* **E. Villari.** (Accad. Lincei, Atti, 9. pp. 61–72, 1900.) —The matter of this paper is dealt with in Abstract No. 1648 (1901). A. D.

HEAT.

2354. *Thermal Properties of Isopentane and Normal Pentane.* **J. Rose-Innes and S. Young.** (Phil. Mag. 2. pp. 208–210, Aug., 1901. Paper read before the Phys. Soc. of London, May 10, 1901.)—If "the departure from Boyle's law" be defined as the value of RT–*pv* for the particular volume and temperature in question, the departure for isopentane appears, within the limits of experimental error, to bear a constant ratio to the departure for normal pentane at the same volume and temperature. By calculating the values of *pv* for isopentane from the corresponding values for normal pentane, and graphically comparing them with those determined by direct experiment, the authors show that by far the greater part of the difference in the behaviour of these bodies can be attributed to the action of the above law.
W. E. T.

2355. *Expansion of Glass and Porcelain at High Temperatures.* **L. Holborn and E. Grüneisen.** (Ann. d. Physik, 6. 1. pp. 136–145, Aug., 1901.)—This paper forms a continuation of a research on the expansion of hard bodies [see Abstract No. 810 (1901)]. Glass and porcelain present greater difficulties than metals, for in the first place they have smaller coefficients of expansion, and in the second place their conductivity is so small that the temperature is not easily equalised.

In the work on Berlin porcelain the authors used two specimens, one rectangular and the other cruciform in section. Tables are given for all the specimens tried.

It was found that quadratic equations of the following form represent the relation between the change in length and the temperature between 0° and 625°:—

$$\lambda = \left\{3027t + 1{\cdot}177t^2\right\} 10^{-9}$$

and—

$$\lambda' = \left\{3188t + 0{\cdot}936t^2\right\} 10^{-9},$$

the temperature being reckoned in the former equation in degrees, and in the latter in microvolts, on a thermoelectric system.

In working on glass, rods and tubes were used. The results were the same in form as for porcelain, being—

$$\lambda_1 = \left\{5814t + 0{\cdot}804t^2\right\} 10^{-9}$$

and—

$$\lambda_2 = \left\{5852t + 0{\cdot}959t^2\right\} 10^{-9}.$$

The former equation refers to tubes and the latter to rods. P. E. S.

2356. *Radiation of Black Bodies.* **O. Lummer and E. Pringsheim.** (Ann. d. Physik, 6. 1. pp. 192–210, Aug., 1901.)—This paper consists of a historical treatment of the experimental results hitherto obtained in this connection, of a reply to Paschen's criticism on the work of the authors, and of a critical review of Paschen's work. They come to the conclusion that Paschen's latest work cannot be regarded as establishing the validity of Planck's equation. At the same time it nearly represents the truth, and it has the advantage over the empirical equation of the authors [see Abstract No. 870 (1901)] of reducing to Wien's equation in the limit for small values of λT. W. E. T.

2357. *Mechanical Equivalent of Heat.* **H. T. Barnes.** (Electrician, 45. p. 969, 1900. Paper read before the Royal Society.)—A determination of the mechanical equivalent of heat was made by imparting electrical energy to a constant stream of water, so as to give a steady difference of temperature at its ends. In terms of the thermal unit at 16° C., the specific heat of water was found to be 1·00530 at 5° C., 0·99735 at 40° C., and 1·00870 at 95° C., with a minimum at 37·5°, and the resulting mechanical equivalent of heat is equal to 4·18876 joules—a result which is about 0·182 per cent. higher than those of Reynolds and Moorby by direct mechanical means [see also Abstract No. 1879 (1899)]. The difference is ascribed to the e.m.f. of the Clark cell, to which the electrical measurements were referred. The actual cell was not considered wrong in itself, but if the e.m.f. of the Clark cell is assumed to be 1·43325 volts instead of 1·4342, the results are in agreement with those of Rowland. W. R. C.

2358. *Dissipation of Heat in a Thick Wall with a Radiating Face.* **J. Boussinesq.** (Comptes Rendus, 133. pp. 497–502, Sept. 30, 1901.)—The method of a former note [see Abstract No. 2012, 1900] is here extended to the general case wherein the initial temperatures are given by $f(x, y, z)$ instead of $f(x)$.

In the particular case where $f(x,y,z)$ is of the form $\chi(x) \exp(-y^2/b^2 - z^2/c^2)$, the isothermal surface for temperature u at time t is of the form—

$$y^2/(b^2 + 4a^2t) + z^2/(c^2 + 4a^2t) = \psi(x, t, u),$$

so that its trace on any plane parallel to the face is an ellipse which becomes more and more circular as the time goes on. R. E. B.

2359. *Construction of Entropy Diagrams from Steam-engine Indicator Diagrams.* **G. Wilson** and **H. Noble.** (Manchester Lit. and Phil. Soc., Mem. 45. 10. pp. 1–12, 1901.)—The indicator cards for all the cylinders of a compound engine should be referred to *unit mass* of mixed steam and water; the diagrams are then to be *reduced* by subtraction of the volumes of the clearance steam, and finally converted into entropy diagrams by Boulvin's graphic method. The reduction is made by Osborne Reynolds' method, with the assumptions, that during expansion the clearance steam follows the same law as the rest of the steam in the cylinder, and that the steam is dry at the beginning of compression. There is uncertainty as to the behaviour of the clearance steam at pressures below that corresponding to release, but this does not affect the important parts of the diagrams. R. E. B.

REFERENCE.

2360. *Possible Attainment of Absolute Zero Temperature.* **G. Martin.** (Chem. News, 84. p. 73, Aug. 16, 1901.) R. E. B.

SOUND.

2361. *Stability of Sound Vibrations.* **C. Barus.** (Science, 14. pp. 403–405, Sept. 13, 1901.)—The experiments here described are intended to show the effect of the damping upon the pitch of a note; and to exhibit the conditions of stability of a system formed by an organ-pipe and a resonator. The apparatus consists of an open organ-pipe giving the note *c''* and a cylindrical resonator which will give notes varying from *b'* to *c''* according to the intensity of the blowing. The resonator is placed so that its axis is perpendicular to the organ-pipe, and the slit of the pipe is towards, and on the same level as, the resonator. When the resonator is gradually moved towards the pipe, the following phenomena are observed:—With the aperture of the resonator towards the pipe, the note rises to *d''* at a distance 1·1 cm. For smaller distances the note returns to the original *c''*. For larger distances (1·7 to 1·5) destructive interference occurs. If the closed end of the resonator be towards the pipe, a flattening of the note occurs. Like effects are produced if the resonator be approached to the top of the pipe instead of to the slit. Explanation is found in the damping term of the expression for the period of vibrations of a system under friction, and having one degree of freedom. The open end of the resonator diminishes the damping to such an extent that the pitch is raised. The closed end increases the damping with contrary effect. A hysteresis phenomenon is also described. With the same arrangement as before, let the resonator be made to approach gradually, and then be withdrawn. Within the region 2·8 and 2·2 cm., the note is *c''* on the forward journey and *d''* on the return. J. W. P.

2362. *Behaviour of Small Closed Cylinders in Organ-pipes.* **B. Davis.** (Amer. Journ. Sci. 12. pp. 185–189, Sept., 1901.)—When a number of small gelatine capsules are placed at the centre of an organ-pipe, and the first overtone is sounded strongly, the capsules arrange themselves in rows across the pipe, as if there were an attraction at their ends in a direction perpendicular to the vibration and a repulsion at their sides parallel to the vibration. The distance between the rows in relation to the number of cylinders, size of cylinders, and amplitude of vibration is investigated. A stopped organ-pipe is used, and, to observe the effect, it has one of its walls replaced by a glass plate. At the node nearest the mouth a rubber diaphragm is placed, and the region observed extends from this to the stopped end. The amplitude of vibration is measured by the torsion balance referred to in Abstract No. 2182 (1901). It is found that the distance between the rows (1) decreases slightly with increase of amplitude; (2) decreases as the number of rows increases. This latter effect is more marked with the larger cylinders. An explanation based upon sound shadows is given, and several sets of illustrative tables are appended. J. W. P.

2363. *Location of Nodes and Loops.* **B. Davis.** (Amer. Journ. Sci. 12. pp. 263–264, Oct., 1901.)—By means of the rotating mill described in Abstracts Nos. 88 and 2182 (1901), the positions of loops and nodes can be found in cases where stationary waves exist, and the decrease of intensity with distance can be accurately measured in open spaces. The mill is mounted in the mouth of an ordinary resonator, so that the plane of rotation is parallel to the mouth. An organ-pipe of considerable power is blown, and the resonator (which is in tune with it) is carried to different parts of the room. The rate of rotation of the mill indicates the intensities at the various points. Experiments made with a long rubber pipe gave 60 feet as the distance at which the mill just ceased to rotate; but, by more delicate apparatus, this could probably be much increased. J. W. P.

2364. *Photographophone.* **E. Ruhmer.** (Ann. d. Physik, 5. 4. pp. 803–810, July, 1901.)—The author gives photographs, on a moving plate, of a steady direct-current arc, of a hissing direct-current arc, of an intermittent arc, of an arc blown out by electromagnets and rekindling itself (with a whistling sound), of the same with longer arc and a rattling sound, with an intermittent current superposed on the direct current, with whistling into a microphone alongside the lamp current, and with the vowel A superposed on the main direct current in the same way. These led to the construction of apparatus which is described, in which telephonic variations affect a lamp-current, and the light presents corresponding variations. This varying light is received by a cylindrical lens, which projects it upon an extremely narrow strip of photographic film rolled past the lens. As the film passes the lens, such strips, contiguous and parallel to one another, are successively and varyingly acted upon, as appears upon development. Then the film is run at an equal rate between the same arc and cylindrical lens on the one hand and a selenium cell on the other. A telephone connected with the selenium cell reproduces the original sound or speech with great accuracy and very loudly. A. D.

2365. *Speaking Arcs.* **P. Janet.** (Soc. Int. Élect., Bull. 1. pp. 371–373, July, 1901.)—The paper contains particulars of the arrangement for using arcs as microphone receivers and also as telephone transmitters employed by C. Léonard, as being found to give the best results. A. D.

REFERENCE.

2366. *Resonators.* **V. Dvořák.** (Phys. Zeitschr. 2. pp. 490–492, 1901.)—An account of experiments undertaken to investigate the effect called the "acoustic repulsion" of resonators. The influence of the form and magnitude of the mouthpiece upon the action of resonators was also investigated. J. J. S.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

2367. *Coefficient of Self-Induction of a Ring of Rectangular Section.* **A. Garbasso.** (N. Cimento, 2. pp. 97–103, Aug., 1901.)—Referring to his paper on Maxwell's function T_{mn} [see Abstract No. 1914 (1901)] the writer says that the formulæ were there developed on the hypothesis of the current being uniformly distributed throughout the section of the ring discussed in that memoir. In the present note he gives mathematical calculations of the coefficient of self-induction of the ring, which cannot be usefully set out in abstract. S. H. B.

2368. *Electromagnetic Fields.* **A. Righi.** (N. Cimento, 2. pp. 104–121, Aug., 1901. Abstract of paper read before the R. Accad. Sci. dell' Instituto di Bologna, Feb. 24, 1901.)—In Hertz's system there is a "characteristic vector," whose components, denoted by Π_x, Π_y, Π_z, each satisfy the differential equation—

$$\Delta\Pi = A^2 \cdot \frac{d^2\Pi}{dt^2},$$

1/A being the velocity of light in free ether. The components, X, Y, Z, of electromotive force are then deduced from it in the form—

$$X = \frac{\partial}{\partial z}\left(\frac{\partial\Pi_x}{\partial z} - \frac{\partial\Pi_z}{\partial x}\right) - \frac{\partial}{\partial y}\left(\frac{\partial\Pi_y}{\partial x} - \frac{\partial\Pi_x}{\partial y}\right), \quad\ldots\ldots\ldots\ldots\ldots(1)$$

with corresponding expressions for X and Y. And L, M, N, the components of magnetic force are deduced in the form—

$$L = A\frac{\partial}{\partial t}\left(\frac{\partial\Pi_z}{\partial y} - \frac{\partial\Pi_y}{\partial z}\right), \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

with corresponding expressions for M and N.

By the symmetry of Hertz's equation, there corresponds another vector, whose components Π'_x, Π'_y, Π'_z have the converse property, so that—

$$X = A\frac{\partial}{\partial t}\left(\frac{\partial\Pi'_y}{\partial z} - \frac{\partial\Pi'_z}{\partial y}\right), \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

$$L = \frac{\partial}{\partial z}\left(\frac{\partial\Pi'_x}{\partial z} - \frac{\partial\Pi'_z}{\partial x}\right) - \frac{\partial}{\partial y}\left(\frac{\partial\Pi'_y}{\partial x} - \frac{\partial\Pi'_x}{\partial y}\right). \quad\ldots\ldots\ldots(4)$$

The relation between this second vector and Maxwell's vector potential is pointed out in a note. Also $\frac{\partial\Pi_z}{\partial y} - \frac{\partial\Pi_y}{\partial z}$ &c., are connected with $\frac{\partial\Pi'_y}{\partial z} - \frac{\partial\Pi'_z}{\partial y}$ &c. by the same relation as those which connect the magnetic with the electric force.

The writer applies the theory to certain cases of electric charges or poles in motion, namely (1) a simple electric dipol or vibrator, (2) the circular vibration of a dipol, (3) the vibrations of an ion.

He further considers the electromagnetic field produced (1) by the uniform rectilinear motion of an electric charge; (2) by an electric particle in motion in any manner, but with small velocity; (3) by a system of electric charges or electrified lines and planes; (4) by a magnetic lamina in its own plane. He concludes with the remark that the conditions assumed in the last examples are approximately realised in experiments for proving the existence of magnetic force due to electric convection, or in experiments which he suggests to prove the existence of electric force due to magnetic convection. S. H. B.

DISCHARGE AND OSCILLATIONS.

2369. *Discharge-Current from a Surface of Large Curvature.* **J. E. Almy.** (Amer. Journ. Sci. 12. pp. 175–179, Sept., 1901.)—The author studies the discharge from a fine platinum wire of small diameter to a concentric circular cylinder. The wire is stretched along the axis of an insulated brass cylinder, whose ends are blocked by cakes of paraffin wax. By tubes passing through these stoppers, air or other gas can be drawn through the apparatus and different pressures can be obtained. When the same body of air is kept in the apparatus there is a decrease of capacity to carry on the discharge after it has been used for some time, so that in experiments with air a fresh supply of dried gas was continuously drawn through the apparatus. The author finds that the current discharging from the fine wire to the surrounding cylinder is given by the equation—

$$C = \frac{L}{r^3} aV (V - b),$$

where C denotes discharge current; V, potential difference between wire and cylinder; L, length of discharge wire; r, radius of cylinder; b, minimum potential necessary to produce a measurable discharge; a, a constant depending upon the size of the wire, the discharging gas, and the sign of the discharge.

For a given apparatus the variation of the discharge current with the pressure of the gas does not seem capable of being expressed in a simple formula. W. C. H.

2370. *Potential Difference and Damping of Oscillatory Sparks.* **F. Beaulard.** (Comptes Rendus, 133. pp. 336–338, Aug. 5, 1901.)—A minimum value of the damping coefficient is found for a spark length of 6 mm. J. E.-M.

2371. *Action of Light on Sparking Distance.* **A. Garbasso.** (N. Cimento, 2. pp. 15–19, July, 1901.)—With a given sparking distance, such that the sparks occur somewhat infrequently, the frequency will be, say, 24 per 30 sec. in sunshine and only 3·3 in the dark. The effect of sunlight persists for some time. The effect does not appear to be due to ultra-violet radiations, but to heating of the terminals. A. D.

2372. *Curves Produced by Point-discharges.* **R. H. Weber.** (Ann. d. Physik, 6. 1. pp. 96–103, Aug., 1901.)—The figures obtained by de Heen [see Abstract No. 99 (1901)] on holding an electrified resin-slab above the flame of a Bunsen burner, and dusting it with sulphur, can also be produced by means of point-discharges. The discharge from a point to a conductor appears to consist of two parts—of a visible part, which is most marked when the point is positively charged, and which is perhaps due to metallic particles; and an invisible part, which can be rendered visible by interposing a piece of silk between the point and the conductor, is independent of the sign of the charge on the point, and is perhaps due to particles of air. If several points are discharging near together, each has a "discharge-field" which is very sharply defined. The shape of these fields can be reproduced by inserting a piece of "bromide paper" between the silk and the conductor. The field for a single point is more or less conical and gives a circular figure, but where two fields meet each becomes flattened, and in the photograph the boundaries are marked by lines which are quite straight in the centre of the figure, but broaden out at the open ends into hyperbolic forms. The general appearance of the figures is in many cases like that of a honeycomb. These figures are identical with those produced on dusting sulphur over a slab which has been exposed to the discharge from several points, the dark lines of the photograph corresponding with the streaks of sulphur on the slab.

The invisible discharge appears to consist of material particles, since the boundary line separating two discharge fields can be blown aside by a current of air. From the extent of the displacement the velocity of the particles forming the discharge was found in two experiments to be 9·8 and 12·1 metres per second. T. M. L.

2373. *Radio-activity.* **P. de Heen.** (Revue Scientif. 16. pp. 161–170, Aug. 10, 1901.)—Almost all foci of disturbance of the ether (flames, brush discharges, hot bodies, electric sparks, radio-active substances, &c.) produce an emanation comparable to that of a Crookes tube; and when this reaches a surface the action is as if the emanation were a fluid, or produced a fluid, distributed on the surface impinged upon, just as liquid would be by a jet of elastic liquid. It is as if these foci emitted ether, which on encountering matter of sufficiently small density, carried it with it mechanically. A new method of detecting the effect of the emanation upon a surface is furnished by the use of a thick card coated on both sides with colophane to which a little white wax has been added. This is first electrified by rubbing it in all directions and then exposed to the actions under study. On dusting it afterwards with sulphur, figures are developed which show the distribution of the charge on this plate. The charge has been driven into positions the same as those into which liquid would have been heaped up by a jet, or by a number of jets, as the case may be. A long series of very curious experiments of this order is described under the influence of flames, brush discharges, sparks, radio-active substances, superficial chemical activity, surfaces modified by the impact of light, Röntgen rays, and incandescent bodies. In the propagation of the emissions referred to there is a logarithmic law analogous to that of the conduction of heat, but the phenomena bear no close relation to diffusion. There seems to be an analogy to heat, in so far that we have to do both with conduction and radiation, but not with radiation originating in oscillation; rather an emission ranging from electrolysis (matter) through kathode and other rays to Röntgen rays (ether); and ionisation has to do, not with atoms, but with sub-atoms. A. D.

2374. *Decrement of Electrical Oscillations.* **A. F. Sundell** and **H. Tallqvist.** (Ann. d. Physik, 4. 1. pp. 72–98, 1901.)—The decrement observed in oscillations which arise on charging a condenser not agreeing with the calculated value, the paper treats of the causes of disagreement, and the corrections necessary for an accurate determination of the decrement.

For a circuit of resistance R, containing a battery and a coil of self-induction L, and connecting the coatings of a condenser of capacity C, an equation is found in which terms are introduced for the insulation resistances r and r' of condenser and coil. The capacity is next assumed to be variable, and the special case where the capacity alters uniformly with time is taken, and the equation of charging altered to suit this condition. The capacity variation is shown to have no effect on T, the period of oscillation, and the expression for the decrement shows that by uniform change of capacity the logarithmic decrement, $\lambda = \frac{\pi}{2} R \sqrt{\frac{C}{L}}$, increases by the amount $\pi h \sqrt{\frac{L}{C}}$, where h is the change of capacity per sec. The calculation of the decrement from a curve of charging is given *in extenso* for a case in which C = 1·0119 microfarad, L = 0·5988 henry, and R = 3·191 ohms, the experimental data having been collected by Tallqvist in 1896 (Wied. Ann., 1897). A table is given with twenty scale readings corresponding to successive minimum and maximum charges while the condenser was being charged, and from these the mean normal charges are calculated and corrected by a graphic method. This mean normal charge increases with the time. The determination of the damping factor is next considered, and the logarithmic decrement is corrected, first for the capacity increase, and second for the full capacity and the corresponding normal charge. The quantity $\gamma = \lambda \times 0{\cdot}43429$ being chosen for convenience of calculation, the table of corrected decrements (γ) shows a variation between the values 0·02040 and 0·02265, which is put down to experimental error. Instead of taking the arithmetic mean of the decrements, a new table is made up from the values of the extreme charges M_0, M_1, M_2, &c. These are dealt with in pairs, *e.g.*, $M_1 - M_0$ and $M_{19} - M_{20}$, $M_1 - M_2$ and $M_{19} - M_{18}$, and so on. The next column contains logarithms of these quantities, the next is a column of differences, and the fourth contains the means of successive differences. These mean values are corrected, and the reduced values so obtained are 18, 16 . . . 2 times γ, from which nine values of γ are obtained, the mean of which is given by $\gamma = 0{\cdot}02128 \pm 4{\cdot}3$. Another method, in which the capacity is taken as oscillatory with the charges, gives $\gamma = 0{\cdot}02141 \pm 4{\cdot}2$.

By removing the coil, curves of charging were obtained which exhibited the change of capacity with time. Although the capacity only reaches its full value after about 2 seconds' charging, the instantaneous charge after a very short time differs from the maximum value merely by a few tenths per cent.

The expression $\gamma = a + b\mathrm{R}$ is given as the relation between the decrement and the resistance of the circuit, and the values of the constants a and b may be found from those of γ and R. Their theoretical values are—

$$a = \mathrm{M}\frac{\pi}{2}\sqrt{\frac{\mathrm{L}}{\mathrm{C}}}\left(\frac{1}{r} + \frac{1}{r'}\right), \quad b = \mathrm{M}\frac{\pi}{2}\sqrt{\frac{\mathrm{C}}{\mathrm{L}}},$$

M being 0·43429. The value of $\frac{1}{r} + \frac{1}{r'}$ remains practically constant while r is varied; $\frac{1}{r'}$ is therefore negligible, and the experimentally found value of a thus gives a means of measuring the insulation resistance of an inductive coil. The method may also be employed to determine the conductivity of feeble conductors. With regard to the coefficient b, experiment and theory agree. Its value found by experiment may therefore be used in conjunction with the formula $\mathrm{T} = 2\pi\sqrt{\mathrm{LC}}$ to determine inductances and capacities. G. E. A.

2375. *Radiation of Ions from Wire Carrying Oscillatory Current.* **O. W. Richardson.** (Cambridge Phil. Soc., Proc. 11. pp. 168–178, Aug. 10, 1901.)—With a period of 14×10^{-8} sec. and a current density at the surface of $1{\cdot}8 \times 10^{6}$ amperes per sq. cm., no ionic radiation was detected. J. E.-M.

2376. *Transmission of Hertzian Waves through Liquids.* **C. Nordmann.** (Comptes Rendus, 133. pp. 339–341, Aug. 5, 1901.)—Experiments on dilute sulphuric acid, saturated solution of common salt, normal solution of potassium chloride, and solution of sulphate of magnesium at its maximum conductivity show that the transparency for the waves employed varies in the same sense as, but more rapidly than, the resistances. J. E.-M.

2377. *Coherers.* **T. Tommasina.** (Archives des Sciences, 11. pp. 557–577, 1901. Communicated to the Physical and Natural History Society of Geneva, April 4, 1901.)—The author maintains the truth of his theory of coherence as against Bose's theory of molecular distorsion, and describes a number of recent experiments in confirmation. He has succeeded in forming visible chains of particles suspended in petroleum between two electrodes. Some of the particles were dielectric, others metallic. The dielectric particles formed into chains first, and as the field increased in strength the metallic particles followed suit, being welded together eventually by minute sparks. Spontaneous decoherence is due, according to the author's view, to the interposition of non-conducting particles between the conducting particles. E. E. F.

2378. *Experiments on Filings Coherers.* **W. H. Eccles.** (Electrician, 47. pp. 682–685, Aug. 23, and 715–717, Aug. 30, 1901.)—The experiments were commenced with the object of revising what was known respecting the relative influences of oscillatory and of steady p.d.'s in promoting coherence in filings coherers. Several eminent authorities hold that the electrical surgings set up in the coherer circuit on the sudden establishment of a connection with a source of e.m.f.—as by any ordinary contact device used in conjunction with a battery—play an important part in the production of coherence. The precise function fulfilled by the electrical surgings has not been exactly outlined, but is imagined to consist in a modifying of the mechanical arrangement of the particles. There has been much conflict of opinion with regard to various points, such as the relative sensitiveness of coherers made with filings of different metals. The confusion appears to have arisen out of the great complexity of the numerous conditions which influence the mechanical and electrical behaviour of filings in a coherer—the phenomenon of pure coherence being, in all probability, greatly disguised and complicated by the preliminary and purely mechanical actions of the particles. If oscillatory discharges are proved to be necessary for efficient coherence, then the effect, on the movements, of displacement currents in the dielectric must be taken into account; while if, on the contrary, steady e.m.f.'s are shown to be sufficient, then other electro-mechanical connections must be proposed.

The author submitted coherers to e.m.f.'s supplied by a copper-sulphate solution potentiometer, avoiding any abruptness in the changes of p.d. The results removed all doubts as to the possibility of coherence by the application of absolutely non-oscillatory e.m.f.'s, and showed that any electrical surgings produced by sudden connection with the source of e.m.f. had little or no influence in compelling coherence beyond that which their maximum voltage gives them. Apparently, then, coherence is an effect caused merely by p.d. It should be observed, however, that it is always possible, even when the applied p.d. increases slowly and continuously, that electrical surgings may be created by the first small discharge which takes place through the coherer along that line of particles which happens at the moment to offer the least resistance. Experiments with six coherers of medium sensitiveness showed that their cohering voltage lay between 1 and 4 volts. Unfortunately the values obtained were irregular, both when mechanical disturbance was avoided as far as possible, and when an uniform degree of mechanical disturbance was applied by a vibrating bell-trembler.

Surprisingly regular results can, however, be obtained as follows: The hammer of a trembler is allowed to strike uninterruptedly the coherer under examination (about fifty vibrations per sec.). During each quiescent stage between the blows coherence takes place, and a current passes through the galvanometer. Decoherence follows immediately, and is succeeded by another coherence, and so on. The galvanometer integrates the pulsating currents traversing it, and gives their mean value. Each movement of the jockey along the potentiometer wire is followed by an increase of deflection. A decided change occurs in the conductivity of the coherer at voltages much lower than the critical voltages obtained by previous methods. Plotting the results obtained, with volts as abscissæ and micro-amperes as ordinates, the sensitiveness of a coherer can be judged by the position and form of its characteristic curve. The occurrence of rapid coherence is indicated by convexity towards the lines of e.m.f. With all the coherers examined (except those known to be remarkably non-sensitive) some curvature is observed under comparatively small e.m.f.'s. As the applied e.m.f. increases, the current increases gradually—never suddenly. After a certain increase, the relation between current and e.m.f. becomes approximately linear. There is complete correspondence between the sensitiveness of a coherer to electromagnetic radiation and the position on the chart of the characteristic curve obtained by the above method. Electrical surgings, such as are no doubt produced in any circuit to which an e.m.f. is abruptly applied, have no effect —as surgings—in producing coherence. The phenomenon of coherence, as Branly and others have always insisted, is an effect of e.m.f. merely. Coherence is a continuous phenomenon, and there can be no true "critical voltage." The author considers that the common expressions "the impinging of waves" and "the incidence of radiation in a coherer" might with advantage be deleted from our phraseology. He gives a kinetic theory of the filings coherer, which makes the typical coherer consist of filings free to move throughout the space of a narrow crevasse, bounded at its ends by plane conducting surfaces. D. E. J.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2379. *Resistance of Bismuth in a Magnetic Field.* **G. C. Simpson.** (Phil. Mag. 2. pp. 300–311, Sept., 1901.)—Lenard found that the resistance of bismuth in a magnetic field was different to continuous and to alternating currents; the resistance, too, was found to vary with the frequency; but the results obtained by different experimenters, as to the way in which it varies, do not agree. The author's experiments were undertaken with a view to determining the variation of resistance with frequency.

Any change in the resistance of the bismuth may be regarded as an e.m.f. set up in the bismuth, and is named by the author the "bismuth e.m.f." If the change is really a change in the resistance, this bismuth e.m.f. will be opposite in phase to, and of the same wave-form as, the current causing it. If there be anything of the nature of self-induction or capacity in the bismuth, the phase of the bismuth e.m.f. will be displaced, and possibly the wave-form of the current altered. The methods followed are fully described, and curves and table of the results given. It was found that the bismuth e.m.f. lagged behind the current producing it, by an angle α, where $\tan\alpha = 1{\cdot}18 + \frac{18{\cdot}2}{n}$ and n is the frequency between values of 10 and 60 ∿, and that its value was proportional to $0{\cdot}0085 + 0{\cdot}00089n$. G. H. B.

2380. *Electric Conduction in Metals.* **E. Riecke.** (Phys. Zeitschr. 2. p. 639, Aug. 3, 1901.)—A conductor was made up of an aluminium cylinder placed longitudinally between two copper cylinders, all put under heavy pressure, and a current was passed through for twelve months. There was no appreciable alteration in the weights of the three cylinders. This would indicate that metallic ions do not play any part in metallic conduction, as the author had anticipated they would do (Ann. Phys. Chem., 1898). A. D.

2381. *Temperature Gradient in a Wire heated by an Electric Current.* **A. Corazzol.** (Elettricità, Milan, 20. pp. 584–585, Sept. 14, 1901.)—The author derives an expression giving the temperature at any point of the diameter of a long cylindrical conductor heated by a current. The temperature gradient is a parabola, whose axis coincides with the axis of the conductor. He also treats the general case, where the conductor is not a cylinder. G. H. B.

2382. *Conductivity of Liquid Dielectrics.* **E. v. Schweidler.** (Akad. Wiss. Wien, Sitz. Ber. 109. IIa. pp. 964–978, 1900, and Ann. d. Physik, 5. 2. pp. 483–486, May 29, 1901.)—A current is passed through pure commercial toluol between two horizontal parallel plates, and measured by a delicate high-resistance galvanometer, a known e.m.f. being applied. Results are given for e.m.f.'s varying from 5 to 800 volts, showing that the current decreases with time, first rapidly, and afterwards slowly. This decrease is ascribed to a fall in the conductivity, or fatigue of the dielectric, since little or no polarisation is observed. If the e.m.f. be removed for a time and again applied, the current is greater than when it was cut off. This is explained as a recovery from the fatigue, the recovery being greater the longer the period of rest:—

Interval of Rest. Min.	Increase of Current. Per cent.
0·5	4·3
1	7·5
2	12·7
4	18
5	27

Hertz had explained the above increase as due to the combination of the main with the residual current. If the current be reversed after being on for some time it increases temporarily. The fatigue and recovery after rest and on reversal are all more marked with higher e.m.f.'s. An experiment is carried out to show that there is a strong analogy between a liquid dielectric and an ionised gas. A current at 800 volts is passed through toluol by means of two zinc plates 24 mm. apart, and the potentials at various points between the plates are measured by means of an immersed Pt wire, the distance of which from the electrodes could be accurately measured. The potential gradient is shown to be greatest near the electrodes, indicating the presence near the anode of free negative, and near the kathode of free positive charges. In the second paper the variation of e.m.f. with current is given, as shown in the following table, the current being measured after having reached a constant value. Petroleum was the liquid employed.

E.M.F.	Current.	E.M.F.	Current.
Volts.	10^{-10} Amps.	Volts.	10^{-10} Amps.
5	8	100	91
10	17	300	218
15	21	400	276
50	55		

Koller's result that the current increases more slowly than the e.m.f. is thus verified. The addition of small quantities of impurities, soluble or insoluble, made no great change in the dielectric conductivity, whereas the increase in that of benzol and toluol exposed for days to the air, the rapid increase when the surface was breathed on, and a reduction of the conductivity of benzol to one-fifth its former value after distillation over sodium, show that the amount of water present has a great influence on the conductivity, if it be not its cause. Warburg's view that the deviation of badly conducting substances from Ohm's law is due to the presence of small quantities of better conducting electrolytes is supported by these experiments. The following values of conductivity were found :—

Substance.	K in $\text{Ohm}^{-1}\ \text{cm.}^{-1}$.	Substance.	K in $\text{Ohm}^{-1}\ \text{cm.}^{-1}$.
Toluol	6×10^{-13}	Petroleum	3×10^{-13}
Benzol	$2\text{–}3 \times 10^{-13}$	Benzine	3×10^{-15}
„ distilled...	6×10^{-14}	Hexane	4×10^{-16}

An experiment in which one of the plates was heated failed to show the presence of a thermo e.m.f. of so much as 1 volt, much less that required by Liebenow's formula when applied to insulators. G. E. A.

2383. *Capacity of Aluminium Cells.* **A. Franchetti.** (Rivista Sci.-Industriale, 33. pp. 121–123, Aug. 15, 1901. From the Rivista Tecnica di Torino.)—The author has measured the electrolytic capacity of cells composed of two aluminium electrodes in a 20 per cent. solution of the double tartrate of sodium and potassium. He determined the advance of the current over the pressure by the three-ammeter method, and also by plotting the curves by a Joubert contact-maker. At a constant frequency of 42 ∾ , the capacity of the cell per sq. cm. of electrode was in microfarads at 87·5 volts, 0·058; at 159 volts, 0·069; at 162·5 volts, 0·083; and at 171·5 volts, 0·127. At a pressure of about 200 volts, the current rose very rapidly and increased as the electrode surface was diminished. The capacity is independent of the frequency, but the ohmic resistance decreases more rapidly than the frequency increases. The cell does not sensibly change the forms of the current and pressure curves. G. H. B.

2384. *Use of Geissler Tubes for Measuring Small Capacities.* **J. Borgmann.** (Phys. Zeitschr. 2. pp. 651–658, Aug. 10, 1901.)—A paper on the same lines as that referred to in Abstract No. 1029 (1899). The capacity of a Geissler tube measured in this way, for different pressures of gas, increases from 0·85 c.g.s. units at atmospheric pressure, up to 4·62 at 1 mm. pressure, and then gradually decreases to 3·92 at ·04 mm. Interesting experiments are described on the capacities of various combinations of tubes. R. S. W.

2385. *Electrostatic Capacity of the Human Body.* **G. de Metz.** (Comptes Rendus, 133. pp. 333–335, Aug. 5, 1901.)—The human body acts, as regards capacity, exactly as a metallic conductor of the same shape and size would do. Its capacity varies with the posture and with the position of other conductors in its neighbourhood. On an insulating table in the centre of a large room, as far as possible from all conductors, the average value is about 0·00011 microfarad. J. E.-M.

2386. *d'Arsonval Galvanometers.* **G. Kümmell.** (Zeitschr. Elektrochem. 7. pp. 745–750, July 4, 1901.)—Experiments made at the Reichsanstalt show that a d'Arsonval galvanometer works under its best conditions when its period is double the period on open circuit. The total resistance of the galvanometer circuit is then very nearly that which makes the galvanometer dead-beat.

The author has determined for a number of d'Arsonval galvanometers the value of the resistance fulfilling this condition, and compares it with the value calculated from des Coudres' formula. The experimental value of the resistance is considerably higher than the calculated, being on the average about 75 per cent. more.

The author further studied the effect of variations in the field strength, by replacing the permanent magnet of a Siemens galvanometer by an electromagnet. The deflection for a given potential difference was found to be a maximum for a field strength of 144, the outside resistance being always adjusted to make the galvanometer dead-beat. Up to a field of 1,100 the ratio of resistance to the square of the field strength was constant.

G. H. B.

2387. *Galvanometer Shunt-box.* **W. Volkmann.** (Elektrotechn. Zeitschr. 22. p. 653, Aug. 15, 1901.)—The author connects to one galvanometer terminal, one terminal of each of, say, three shunts, 1/9, 1/99, and 1/9999; the other galvanometer terminal is connected to the other terminal of the 1/9 shunt; between this and the other terminal of the 1/99 shunt is a resistance equal to 9/10 of the galvanometer resistance; between the terminals of the 1/99 and 1/9999 shunts is a resistance equal to 99/1000, and between the terminal of the 1/9999 shunt and that of the shunt box is a resistance equal to 9999/10000 of the galvanometer resistance. These shunts and resistances are joined up to contact blocks having six plug-holes and three plugs, the different combinations of which give sensibilities equal to 1, 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}, and 10^{-7} times the unshunted sensibility, while the total resistance of the galvanometer and shunt box remains always the same. G. H. B.

2388. *Power-Factor Indicators.* **W. H. Browne, Jr.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 475–500, June and July, 1901.)—In cases where the power-factor of a station load can be adjusted to unity by varying the excitation of synchronous motors or converters, it is necessary to have some means of ascertaining the exact point of balance. This point is often determined by the minimum reading of an ammeter in the line, or by comparing the volt-amperes and watts. Both these methods are unreliable, for a small error in reading means a large error in balance, when the power-factor approaches unity. This is illustrated by curves.

To give accurate results for large power-factors, measurements must not involve the cosine, so that either the phase-angle itself or the wattless volt-amperes must be measured.

The author then describes various forms of phasemeters. Phasemeters measuring the angle directly are: Tuma's, in which a moving system of two coils with their planes at right angles carries the shunt current in one coil, and a current in quadrature with it in the other coil; this system is in the field of two coils carrying the main current; the deflection of the moving system is the phase angle. Anglemeyer, Korda, Hess, Rossi, and Arnò make use of the principle that if two coils, carrying equal currents, are inclined at an angle equal to the supplement of the phase angle between the currents, the resultant rotating field will have a constant value. If the inclination of the coils be varied till this condition is obtained, the phase angle is indicated directly. Phasemeters measuring a function of the phase angle are: Puluy's, in which two electromagnets carrying the two magnets vibrate two mirrors in planes normal to one another; a ray of light reflected from the two mirrors on to a screen describes an ellipse; if one magnet only acts, the ray will describe a straight line; the ratio of the length of this line, cut off by the ellipse, to its whole length, is the sine of the phase angle.

Moreland's and Claude's phasemeters are based on the same principle, but the latter measures the cosine of half the phase angle. A Siemens dynamometer, having two fixed coils and one moving coil closed on itself, measures the cosine of the angle, which is deduced from three readings, one with one current through one coil, a second with the other current through the other coil, and a third with both currents. Arnò's phasemeter is an ordinary dynamometer with an additional moving system consisting of a pair of short-circuited coils in planes at right angles to each other; it measures the tangent of the angle.

In Breitfield's method for three-phase currents, the main coil of an ordinary wattmeter is connected in one line, and the shunt coil, first between this and the second line, and next between the first and third lines; from the two readings the tangent of the angle is deduced.

The General Electric Company's instrument is based on the principle that the ratio of the readings of two wattmeters used to measure the power of a three-phase system varies with the power-factor, and is unity when the power-factor is unity. The instrument consists of two wattmeters, the moving coils of which are attached to the same spindle.

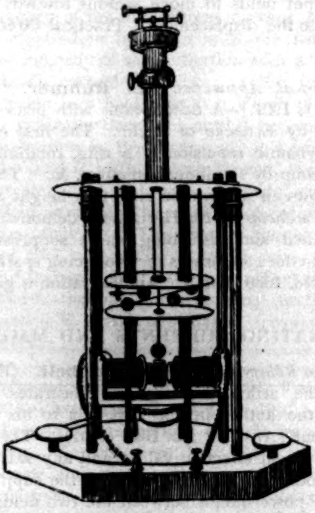
Phasemeters measuring the wattless volt-amperes or E.C. sin ϕ, are: Dobrowolski's, in which fields due to the two currents act on a disc, as in an induction meter, with the difference that the shunt current is in phase with the e.m.f. There is torque on the disc only with a difference of phase, and the torque is proportional to E.C. sin ϕ. The Allgemeine Elektrizitäts Gesellschaft's instrument is based on the same principle.

The author then gives curves and tables showing the results of experi-

ments on a Siemens dynamometer, a Weston wattmeter, and a Shallenberger meter, and on power-factor meters. The dynamometer was used with a condenser in series with its pressure coil; the Weston wattmeter was used on a two-phase system, and the Shallenberger meter was used with a non-inductive resistance in series with a condenser, in place of its choking coil.
G. H. B.

2389. *Dielectric-Polarisation Balance.* **F. Maccarrone.** (N. Cimento, 2. pp. 88–96, Aug., 1901.)—This apparatus, which is designed to demonstrate and measure the polarisation of dielectric media, and to show the existence of a retardation of the polarisation due solely to viscosity, is represented in the accompanying figure.

It consists of two brass discs, half-way between which two glass discs (microscope cover glasses), lying in a vertical plane passing through the axis of suspension, are bifilarly suspended. In one of the positions that these glass discs can be made to occupy by rotating the graduated head of the apparatus, two other glass discs are fixed from the top of the apparatus. The movement of the balance is observed by means of a reflecting mirror, and is made aperiodic by a magnetic damping arrangement. In working the apparatus to demonstrate dielectric phenomena, the upper brass disc is connected with a battery of Leyden jars, and the lower brass disc with earth. A gradually increasing repulsion of the movable from the fixed glass discs is seen. Both brass discs are now connected to earth; the movable glass discs return *exactly* but only slowly (after several minutes sometimes) to their original positions. The method of measuring the absolute values of dielectric viscosity by means of the apparatus is sketched in the paper.



D. H. J.

2390. *Wehnelt Interrupter.* **H. Starke.** (Deutsch. Phys. Gesell., Verh. 3. 10. pp. 125–128, 1901.)—The author investigates the case of very small electrodes. The rate of interruption, other things being equal, can be increased by diminishing the diameter of the electrode wire. If the diameter is reduced to about 0·03 mm., and the current is regulated to about 0·02 amperes, the interruption is sharp and rapid enough to produce a tone in a telephone in the circuit. This method of interrupting the current is said to be particularly well suited for bridge and telephone methods of measuring electrolytic and other resistances. R. A.

2391. *Braun's Tubes for Measuring Electric Fields.* **W. I. Milham.** (Phys. Zeitschr. 2. pp. 637–639, Aug. 3, 1901.)—When the potential difference between the plates is altered by a given amount, the displacement of the light-spot from its normal position undergoes a proportional alteration. When the potential difference remains unchanged and the light-spot is not in its normal position, the light-spot tends to move steadily towards this position, with a speed proportional to the displacement. Practical directions are given. A. D.

2392. *New Physical Apparatus.* **E. Ruhmer.** (Phys. Zeitschr. 2. pp. 478–479, May 11, 1901.)—A description, with prices, of three new sets of apparatus made by Ernecke of Berlin. The first is to illustrate Elihu Thomson's electrodynamic repulsion of a ring, rotation of a copper plate, lighting of a glow lamp by self-induction effect, &c. The application of 220 volts to the coil throws an aluminium ring to a height of 6–7 metres. The second apparatus is a cheap set for Hertz wave demonstration, the oscillators being much simplified and disturbing waves suppressed. The third is a practical form of Miethe's apparatus for producing spark spectra without air lines [see Abstract No. 1638 (1901)]. An illustration is given. G. E. A.

ALTERNATING CURRENTS AND MAGNETISM.

2393. *Theorem in Rotary Fields.* **A. Campbell.** (Elect. Rev. 49. p. 256, Aug. 16, 1901.)—The article explains and illustrates a theorem proved mathematically by the author in the appendix to his paper on Alternate-current Measurement [Abstract No. 1944 (1901)]. The theorem is: If two alternating fields of equal effective values, and any wave-forms, be inclined in space to one another at an angle equal to the supplement of the angle whose cosine is the power-factor between the two fields, then the resultant rotary field will have a constant effective value in all directions perpendicular to an axis of rotation. G. H. B.

2394. *Constancy of Magnets in Iron Cases.* **I. Klemenčič.** (Ann. d. Physik, 6. 1. pp. 174–180, Aug., 1901.)—The author observed the moments of three permanent magnets over a period of about five months, the magnets being kept in iron cases. These were formed of gas-pipe, the ends consisting of screwed iron plugs, and were lined with cottonwool to protect the magnets from vibration and shocks. During the first few days the magnets showed a small change, but after this the moment of each magnet remained constant within the limits of error of the experiments. The initial change was a decrease of moment of about $\frac{1}{4}$ per cent. in the case of one magnet and increases of 1 per cent. and $\frac{1}{3}$ per cent. in the other two magnets. These changes the author attributes to magnetisation or demagnetisation of the iron case. To test the protective effect of the cases against shocks, a magnet, 10 cm. long in its case, was dropped ten times from a height of 1 metre on a stone floor: no change of moment resulted. The author further made measurements to determine the shielding of the cases against magnetic fields; he concludes that an external field is diminished to less than one-third of its value inside the case. The experiments show that there is a great advantage in keeping magnets in iron cases. G. H. B.

2395. *Magnetisation by Intermittent Currents.* **K. Honda** and **S. Shimizu.** (Phys. Rev. 13. pp. 81–90, Aug., 1901.)—An intermittent direct current is produced by means of a Pupin interrupter [see Abstract No. 2043 (1900)]. This current, whose mean strength is measured by a Thomson graded galvanometer, is sent through a magnetising coil containing the wire under test. A magnetometer and compensating coil are placed due east of the magnetising coil. A summary of the results obtained is as follows: (1) For iron, steel, and nickel wires, the magnetisation in weak fields decreases as the frequency of the intermittent current increases; while in stronger fields the magnetisation increases with the frequency. (2) The difference between the intensity of magnetisation with a definite frequency and that with a steady current increases as the field increases, and attains its maximum value in a field near that which gives the maximum permeability; it then gradually decreases until it becomes zero (*i.e.*, when the intensity of magnetisation is the same with this frequency as with a steady current); as the field is further strengthened, the intensity of magnetisation becomes greater than that with a steady current. (3) In the hysteresis curve the field in which the change of magnetisation vanishes increases with the frequency. (4) The area of the hysteresis curve for the maximum field of 27·7 c.g.s. units increases with the frequency; it reaches a maximum and then gradually decreases. These facts are accounted for on Wien's hypothesis that magnetisation has inertia. The paper is illustrated with I–H and μ–H curves of different frequencies for soft iron, tungsten steel, and nickel. E. C. R.

2396. *Pyro- and Piezo-magnetism of Crystals.* **W. Voigt.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 1. pp. 1–19, 1901.)—The author gives an account of his observations on various crystals belonging to different crystallographic systems. He considers that the recorded observations determine, for the pyro- and piezo-magnetic excitement, only superior limiting values. The extraordinary smallness of the respective effects can be understood from the theory of ions, if it is remembered that in the expression for the magnetic action of a moved electron the velocity of light enters as denominator; yet, along with the conditions giving rise to the pyro- and piezo-magnetic effects, other unknown circumstances come in, so that the order of magnitude cannot be assigned beforehand with any certainty. The author's observations on this magnitude are therefore of interest. J. J. S.

2397. *Oscillations of Glow-Lamp Filaments in a Magnetic Field.* **R. Kempf-Hartmann.** (Phys. Zeitschr. 2. pp. 677–681, Aug. 24, 1901.)—It has often been observed that the carbon filaments of glow lamps in their cold condition are set in lively vibration by the slightest shock. The filament is at ordinary temperatures glass hard, and a stretched piece gives on plucking a somewhat high note. The whole filament forms an elastic system of very small inertia. With the naked eye its time of vibration cannot be observed.

On putting the lamp close to the ear a metallic sound can be heard, which seems to be made up of musical notes which have nothing in common with the large vibrations of the whole elastic system, for in these the number of oscillations is only about 20 per second. When the filament is incandescent it can be set in strong vibration with amplitudes of about 2·5 cm. These oscillations are very quickly damped, and the filament appears when glowing to have lost its elasticity. Stroboscopic measurement shows that a magnetic damping comes into play.

Let a permanent magnet (or an electromagnet with a steady current), be brought into the neighbourhood of a lamp, supplied with alternating current; or again, let an electromagnet excited by an alternating current be brought near a lamp with steady current. Then the band of light formed by moving the bright filament spreads out when the magnet is brought near. The form of the band and the amplitude of the vibrations, as well as their uniformity, depend on the situation of the magnet.

The explanation is simple. The current produces, according to its direction, a field of force, which either aids or opposes the permanent field. The glowing filament follows the attractions and repulsions. A magnetic needle would in the main behave in just the same way, but its inertia is so great in proportion to the moving forces that its motion only amounts to a slight tremor. Similar effects may be observed with various descriptions of electrodynamical measuring apparatus.

Two such systems consisting of a glow lamp and a permanent magnet may be arranged so that the vibrations of the filaments take place in directions at right angles, and thus Lissajons' figures may be obtained. Many experiments may be made with a single lamp and permanent magnet which will clearly illustrate the vibrations of elastic bodies.

The behaviour of the vibrating filaments is illustrated by photographs.

J. J. S.

2398. *Hall Effect in Very Thin Metallic Films.* **G. Moreau.** (Journ. de Physique, 10. pp. 478–493, Aug., 1901.)—The conclusion drawn from a series of experiments on films of silver and nickel is, that for films approaching 5×10^{-6} cm. thickness the accepted law does not apply. The results are most simply explained on the supposition that the outer layers of a film, to a depth of $2{\cdot}5 \times 10^{-6}$ cm., have properties differing from those of the interior. Thus the total thickness of a film is the sum of the outer layers together with the thickness of the homogeneous interior. Hence for films whose thickness is not much greater than 5×10 cm. the usual formula requires amendment so that it may express the fact that the qualities of the outer layers are different from those of the interior.

The accepted formula—

$$E = \frac{aHI}{e},$$

where E is the lateral e.m.f.; H the magnetic field; I the primary current; e the thickness of the film; a a coefficient characteristic of the metal—is not correct, since experiment proves that a varies with the thickness. This formula may, however, be transformed into the following:—

$$E = \frac{a}{\rho} LHW,$$

where L is the size of the film parallel to the equipotential surfaces of the primary current, of which the potential difference per cm. is W, and ρ is the resistivity of the film.

But from experiment it is found that—

$$\rho = \frac{e}{A(e - 2{\cdot}5 \times 10^{-6})},$$

$$a = \frac{e}{B(e - 2{\cdot}5 \times 10^{-6})},$$

where A and B are true constants independent of the thickness; hence—

$$a/\rho = A/B = K.$$

K is independent of the thickness until the critical thickness is reached. This then is the true coefficient of the Hall Effect, and the equation becomes—

$$E = KLHW.$$

The formula is an important one, showing as it does that the Hall Effect for the equipotential surfaces may exist without current. J. E.-M.

MEDICAL ELECTRICITY.

2399. *Recent Progress in Röntgen Rays.* **Rosenthal.** (Schweiz. Blätter Elektrotechn., Bern, 6. pp. 116–119, Aug. 8, 1901. From a paper read before the Munich Elekt. Verein.)—The author discusses tubes with massive anti-kathodes and means for regulating the vacuum; an appliance, the punctograph, by von Angerer and himself, for locating bullets, &c., consisting of a pair of rings connected by a spring, the method of use being that the image of the bullet, in the body and between the two rings, is centred in the images of both rings, and the skin marked by a pencil at the centre of each ring; and an appliance, the orthodiagraph, by Moritz, Munich, for tracing the true outline of the heart, &c., by making the vacuum-tube travel in correspondence with a travelling pencil on the other side of the patient's body, the effect of this arrangement being equivalent to that of optical parallel projection. A. D.

REFERENCES.

2400. *Modifications of Discharges Caused by Dielectrics.* **K. v. Wesendonck.** (Phys. Rev. 12. pp. 375–376, June, 1901.)—An abstract of a paper which appeared in Wied. Ann. for 1898. R. S. W.

2401. *Damping of a Leyden-jar Discharge.* **Miss H. Brooks.** (Phil. Mag. 2. pp. 92–108, July, 1901.)—By means of a Rutherford detector, the damping of the oscillations and its dependence on the nature of the leads, length of spark-gap, pressure of air, hydrogen and carbonic acid gas in which the spark passes, and on the capacity of the jar itself are here investigated. E. H. B.

2402. *Regulation and Adjustment of Arc Lamps.* **M. E. Chester.** (Elect. Rev. 49. pp. 340–341, Aug. 30, 1901. From the "Technograph.")—The author gives a number of practical notes on the working of various types of arc lamps, with suggestions for remedying defects and avoiding errors in adjustment of the mechanism. A. H. A.

2403. *Measuring the Dispersion of Charges in Air.* **L. Kann.** (Phys. Zeitschr. 2. pp. 621–623, July 27, 1901.)—This paper describes a self-registering apparatus for this purpose. A. D.

2404. *Coherers.* **A. F. Collins.** (Elect. World and Engineer, 38. pp. 251–253, Aug. 17, 1901.)—This is an article giving briefly the history and more essential details of construction of coherers. P. E. S.

2405. *Selenium Cell for Demonstration.* **J. W. Giltay.** (Phys. Zeitschr. 2. pp. 675–677, Aug. 24, 1901.)—This paper describes an apparatus designed to demonstrate the effect of light upon selenium. J. J. S

2406. *Application of the Principle of Energy to Electrodynamic and Electromagnetic Phenomena.* **E. Sarrau.** (Comptes Rendus, 133. pp. 402–407, Aug. 26, 1901.)

2407. *Three-Phase Theory.* **A. Russell.** (Electrician, 47. pp. 639–643, Aug. 16, 1901.)—The author gives solutions of several three-phase problems, without any assumption as to wave form. Amongst the problems considered are (1) the magnitudes and phase differences of the p.d.'s between the mains in three-phase systems. (2) The graphical representation of the voltages in the three-arms of the load (star winding). (3) The potentials to earth of the mains. (4) Diagrams of the currents in a mesh winding. (5) The measurement of power in three-phase circuits. W. G. R.

2408. *Application of Lagrange's Equations to Electrodynamic and Electromagnetic Phenomena.* **E. Sarrau.** (Comptes Rendus, 133. pp. 421–425, Sept. 2, 1901.)

2409. *Induction in an Open Circuit.* **J. Koenigsberger.** (Phys. Zeitschr. 2. pp. 475–476, 1901.)—A study of the induced e.m.f. in an open circuit by means of the quadrant electrometer. E. E. F.

2410. *Secular Motion of Earth's Mean Magnetic Axis.* **L. A. Bauer.** (Terrestrial Magnetism, 6. pp. 73–75, July, 1901.)—A comparison of van Bemmelen's results with those obtained by the author and others. J. E.-M.

2411. *Unifilar Magnetometer of the Magnetic Survey of India.* **H. A. D. Fraser.** (Terrestrial Magnetism, 6. pp. 65–69, July, 1901.)—A concise description of the standard form of instrument used in the survey. J. E.-M.

2412. *Earth's Horizontal Magnetic Force.* **W. Watson.** (Terrestrial Magnetism, 6. pp. 70–72, July, 1901.)—A graphic method for determining the corrections to be applied in evaluating H. J. E.-M.

2413. *Electric Discharges and Allied Phenomena.* **K. R. Johnson.** (Phys. Zeitschr. 2. pp. 648–651, Aug. 10, 1901.)—In this paper the following phenomena are discussed and compared: (1) The behaviour of the spark potential in the case of electric discharges. (2) The electric oscillations in straight wires connected to the conductors of an influence machine. (3) The production of inflammable gas by high-pressure discharges between Wollaston pointed electrodes. (4) The phenomena of the Wehnelt interrupter. J. J. S.

2414. *Report of Magnetic Observations at Falmouth Observatory for the Year* 1900. Latitude 50° 9′ 0″ N., Longitude 5° 4′ 35″ W.; height, 167 feet above mean sea-level. **E. Kitto.** (Roy. Soc., Proc. 68. pp. 415–420, Sept. 12, 1901.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2415. *Argon and its Companions.* **W. Ramsay** and **M. W. Travers.** Roy. Soc., Proc. 67. pp. 329–333, Jan. 8, 1901; Roy. Soc., Phil. Trans. 197. pp. 47–89, July 29, 1901.)—The latter is a monograph (of which the former is an abstract) of the author's work on these gases, giving in detail the preparations of neon, krypton, and xenon, the physical properties of the group, and the methods of determination, with nine illustrations, tables, curves, and a plate of the spectra of Ne, Kr, and X. "Metargon" [see Abstract No. 1370 (1898)] is definitively abandoned: its supposed spectrum was due to carbon in the phosphorus used for removing oxygen. It is shown that if these gases be monatomic, with atomic weights of He, 4; Ne, 20; A, 40; Kr, 82; X, 128; or double their densities, they fall naturally into position in the periodic table; it has not, however, been found possible to deduce accurately the properties of any one of them from those of its congeners. Measurements of the spectra by E. C. C. Baly will shortly be published. The spectra of Ne, Kr, and X cannot be detected in crude argon, even photographically. The colours are—helium, yellow; argon, red-purple; neon, brilliant orange-pink "flame colour"; krypton, pale violet; xenon, sky-blue. The monograph is also published entire in Zeitschr. Phys. Chem., 38. Nov. 1, 1901, pp. 641–689.

S. R.

2416. *Hydrogen Peroxide as an Acid.* **Bredig.** (Zeitschr. Elektrochem. 7. pp. 622–624, May 16, 1901. Paper read before the Deutsch. Elektrochem. Gesell. at Freiburg.)—The author describes the following experiments made under his direction by Calvert, which give confirmation to the view that hydrogen peroxide is an acid. (1) The coefficient of distribution of hydrogen peroxide between ether or amyl alcohol and water is enormously diminished as soon as alkali is added. (2) The freezing-point of N/4 sodium hydroxide solution is not lowered by the addition of $\frac{1}{4}H_2O_2$, although the latter lowers the freezing-point of water by 0·33°. (3) The velocity of hydrolysis of ethyl acetate by alkali is considerably diminished by the addition of hydrogen peroxide. (4) When sodium hydroxide solution is neutralised by an acid, its molecular conductivity diminishes to one-half to one-third of its original value, and the same is found to take place on the addition of hydrogen peroxide. The latter is a very weak acid and has about the same strength as hypochlorous acid, so that its salts show appreciable hydrolysis. The mobility of the anion of hydrogen peroxide in its salts is $a' = 45$. (5) It is shown by direct experiment that hydrogen peroxide in alkaline solution forms an anion which, on electrolysis, travels in the direction of the negative current.

T. H. P.

2417. *Tests of Aluminium Bronzes.* **L. Tetmayer.** (Revue de l'Él., Berne, 10. pp. 124–125, Aug. 31, 1901.)—Details are given of tests carried out in the laboratories of the Zurich Polytechnic School, at the request of the Neuhausen Aluminium Company, who provided the samples. The specific gravity first rises, and then falls, as the percentage of aluminium increases. The maximum strength for soft alloys was obtained with 3·4 per cent. Al, and for hard alloys with 1·4 per cent. Al.

For brass, the elasticity decreases with the increase of aluminium, and is extremely low with only 2 per cent. of the latter. Silicon increases the specific gravity, and reduces the elasticity.

Iron, in the proportion in which it was present in the alloys, was not observed to sensibly influence the physical characteristics.

Aluminium bronze, containing 10 per cent.Al with 1·5 per cent.Si and Fe, is too brittle to be of any practical value. As regards the abrasion by friction, the hard alloys, with less than 89·6 per cent.Cu, lose little in weight, while the soft alloys, with less than 6 per cent.Al, heat, and wear away rapidly.

J. B. C. K.

2418. *Dielectric Constants of Derivatives of Pyridine and Piperidine.* **R. Ladenburg.** (Zeitschr. Elektrochem. 7. pp. 815–817, Aug. 8, 1901.)—The dielectric constants of the following substances were determined at 22° C. by Drude's method, and were found to be as follows :—

Substance.	Formula.	E_{22}.
Pyridine	C_5H_5N	12·56
a-Picoline	C_5H_4MeN	9·46
β-Picoline	C_5H_4MeN	10·71
a-Ethylpyridine	C_5H_4EtN	8·56
a-Conyrine	C_5H_4PrN	7·86
a-Isopropylpyridine	$C_5H_4(CHMe_2)N$	7·68
aβ′-Methylethyl-pyridine	C_5H_3MeEtN	7·95
aa′-Lutidine	$C_5H_3Me_2N$	7·23
*S-Trimethylpyridine	$C_5H_2Me_3N$	6·64
Piperidine	$C_5H_{11}N$	4·33
a-Pipecoline	$C_5H_{10}MeN$	3·55
a-Coniine	$C_5H_{10}PrN$	3·03
a-Isopropylpiperidine	$C_5H_{10}(CHMe_2)N$	2·95
*S-Trimethylpiperidine	$C_5H_8Me_3N$	3·06
N-Methylpiperidine	$C_5H_{10}NMe$	2·90
N-Ethylpiperidine	$C_5H_{10}NEt$	2·49
N-Isopropylpiperidine	$C_5H_{10}N(CHMe_2)$	2·26
*N-Methyl-*a*-pipecoline	C_5H_9MeNMe	2·17

The maximum error in the determinations was not greater than 2 per cent., but the substances marked with an asterisk were available only in small quantities, and their degree of purity could not be determined.

In all cases the displacement of a hydrogen atom leads to a lowering of the dielectric constant, and this effect is most marked when the replacing group is of high molecular weight, and occupies a position near to the nitrogen atom.

T. M. L.

2419. *Molecular Weight at the Boiling-point.* **de Forcrand.** (Comptes Rendus, 133. pp. 368–371, Aug. 12, 1901.)—The author has shown in a previous paper [see Abstract No. 1497 (1901)], that for all chemical or physical phenomena, the ratio $(L + S)/T$ has a constant value of 30, where L is the heat of liquefaction of a gas molecule, S the heat of solidification of this liquid molecule, and T the absolute boiling-point of the compound. The numbers experimentally obtained for the heats of liquefaction and solidification refer, however, not to molecules but to 1 gm. of the substance ; denoting these values by *l* and *s*, the above relation becomes : $(L + S)M/T = 30$, M being the molecular weight. A means is thus furnished of determining the molecular weight of a compound at its boiling-point; the numbers obtained in this way will differ from the true values by not more than 1/15, or 6·7 per cent., which is the greatest error observed in the relation given above. For bromine, the molecular weight thus given is 166, corresponding with 2·07Br: for acetic acid, 97·02 or 1·61 $C_2H_4O_2$, which agrees well with the indication of the vapour density; for iodine, 381·04 or 3I, in accord with the latest researches, which give numbers varying from 2 to 4I, according to the concentration; for mercury M = 237, corresponding with 1·18Hg; sulphur gives 266·1, pointing to a molecule 8·31S; for nitric acid M = 86·44, the mean molecule being 1·37HNO_3; whilst for nitric anhydride, the molecular weight has a value 79·75, which corresponds with 0·74N_2O_5, and indicates that the solidification of liquid nitric anhydride is accompanied by polymerisation, during which heat is evolved. T. H. P.

2420. *Molecular Weight of Chloral Hydrate at the Boiling-point.* **de Forcrand.** (Comptes Rendus, 133. pp. 474–476, Sept. 16, 1901.)—The author applies the relation [previously given by him, see preceding Abstract], existing between the latent heats of fusion and volatilisation, absolute boiling-point and molecular weight, to determine the molecular weight of chloral hydrate. The result seems to indicate that this compound is not completely dissociated at its boiling-point. T. H. P.

2421. *Heats of Volatilisation and of Fusion of some Elements.* **de Forcrand.** (Comptes Rendus, 133. pp. 513–515, Sept. 30, 1901.) [See also preceding Abstract.]—From the general equation $(L + S)/T = (l + s)M/T = 30$, the value of $(L + S)$ can be calculated when T and M are known. This gives a means of determining the latent heat of volatilisation of an element when no direct measurement has been made. For example, in the case of phosphorus, which has the molecular weight 124 in freezing benzene or in boiling carbon bisulphide or in the state of vapour, $T = 560°$ absolute and $S = 5$ cals., so that the latent heat of volatilisation l is 130·4 cals. The sum of the heats of fusion and of volatilisation for an atomic proportion of phosphorus is therefore 4,200, and knowing that $P \text{ (solid white)} + H_3 = PH_3 + 4{,}900$ cals., we have $P \text{ (gas)} + H_3 = PH_3 + 9{,}100$ cals., a heat of formation rather less than that of ammonia from its elements (12,200). Similarly in the case of arsenic, $(l + s) = 68·5$ cals., from which it follows that $As \text{ (gas)} + H_3 = AsH_3 - 39{,}060$ cals.; but it must be noted that the molecular weight of arsenic (300) is only known at the boiling-point, and in heating arsenic up to this temperature molecular charges may occur, resulting in manifestations of heat. Making the same reservation for selenium, we have $Se \text{ (gas)} + H_2 = SeH_2 - 4{,}805$ cals. Also in the case of carbon, taking the boiling-point as 3,000° and the molecular weight as 24, the value 90,000 cals. is obtained for $(L + S)$, allotropic changes being neglected. T. H. P.

2422. *Chemical Reactions in the System—Ether—Water—Hydrochloric Acid.* **F. Jüttner.** (Zeitschr. Phys. Chem. 38. pp. 56–75, Aug. 6, 1901.)—An explanation is sought of the following facts (established by Schuncke):—

(*a*) Ether and water, when saturated with respect to HCl gas at 0° C. and atmospheric pressure, contain respectively 35·6 per cent. and 45·2 per cent. hydrochloric acid.

(*b*) If these two solutions be mixed there is a great evolution of HCl gas and production of heat, and a homogeneous mixture results (one liquid phase).

(*c*) If ether be shaken with a 31·61 per cent. aqueous HCl solution it will only take up 0·236 per cent. HCl. Extrapolation to very concentrated aqueous HCl solution gives for the partition coefficient of HCl between ether and water the value $1/10^{-3}$. On the other hand, the ratio of the solubilities gives 1/1·3.

The explanation suggested is that ether and HCl combine to form a hydrochloride analogous to the compound obtained by Friedel in the case of methyl ether, or to the compounds between alkyl substituted pyrones and HCl investigated by Collie and Tickle, and Collie and Steele.

It is assumed that the partition coefficient of this ether hydrochloride between ether and water lies very much towards the water. With these assumptions the above facts can be fairly well explained. An attempt is made to apply the law of mass-action to the equilibrium in the aqueous solution between the ether, hydrochloric acid, and ether hydrochloride, but reference must be made to the original paper for an account of this.

F. G. D.

2423. *Solid Solutions in Mixtures of Three Substances.* **G. Bruni.** (Accad. Lincei, Atti, 9. pp. 232–241, 1900.)—This paper consists of a study of physical equilibrium in ternary systems in which solid solutions may form. Diagrams are given corresponding to the different possible types of substances forming the system.—A paper on similar lines by **G. Bruni** and **F. Gorni** appears in the Accad. Lincei, Atti, 9. pp. 326–332, Dec. 2, 1900. A. D.

2424. *Carbon at High Pressures and Temperatures.* **Q. Majorana.** (Accad. Lincei, Atti, 9. pp. 224–232, 1900.)—This paper contains a description of experiments on exposing carbon to high temperatures and heavy pressures, with the result of producing compact graphite. For crystallisation of carbon, it is probable that the use of a solvent is necessary. A. D.

2425. *Relation between Solubility and Heat of Solution.* **A. Campetti.** (Accad. Lincei, Atti, 10. pp. 99–102, Aug. 18, 1901.)—To express the heat given out on solution van't Hoff deduced the equation—

$$q = -\frac{4{\cdot}58(\log c_2 - \log c_1)\,T_1T_2}{T_2 - T_1}$$

where c_1 and c_2 are the concentrations of saturated solutions of substances at temperatures T_1 and T_2, not greatly differing from one another. The equation, which is true only for non-dissociating substances of small solubility, was verified by van't Hoff for succinic, benzoic, salicylic, and boric acids. The present paper gives an account of experimental determinations of both the solubility and heat of solution of *strong* solutions of urea and of mannite, and it is found that the experimental values for the heat of solution agree with those calculated from the above formula, if c_1 and c_2 are taken to represent the number of grammes of substance dissolved in the same weight of solvent, and not, as in van't Hoff's equation, the number of grammes of dissolved substance in 100 c.c. of the solution. D. H. J.

2426. *Temperature-coefficient of Susceptibility of Salt-solutions of the Iron Group, especially of Ferric Chloride.* **H. Mosler.** (Ann. d. Physik, 6. 1. pp. 84–95, Aug., 1901.)—Jäger and Meyer have stated that the temperature coefficient of susceptibility of salt solutions of the iron group varies, independently of the concentration, from —0·00219 to —0·00305, that for an 18 per cent. solution of nickel nitrate alone rising to —0·00322. Plessner, on the other hand, working by Wiedemann's method, finds that the temperature coefficient is in all cases —0·00856. In the investigation here described an improved form of Wiedemann's method was used, and the temperature coefficients were determined with a considerable degree of accuracy. In most cases the variations in the temperature coefficient due to changes of concentration are only slight and somewhat irregular; the mean values are, for ferric nitrate —0·00283, for cobalt nitrate —0·00278, for manganese sulphate 0·00266, and for nickel sulphate —0·00282. In the case of ferric chloride, however, a remarkable maximum occurs; solutions containing less than 28·5 per cent. or more than 88·5 per cent. of the salt have a normal temperature coefficient which is remarkably steady at —0·00270 (mean value), but between these limits the temperature coefficient rises to a maximum value, —0·00858, at 33 per cent. This maximum does not appear to be connected with any of the other chief physical properties of the solution, such as the relative permeability, the electrical conductivity or the freezing-point depression, and no explanation has been found of the exceptional behaviour of these solutions. T. M. L.

2427. *Electrolytic Conductivity of the Hydrates of Sodium and Potassium in Solution in Glycerine.* **G. di Ciommo.** (N. Cimento, 2. pp. 81–87, Aug., 1901.)—Monti (Atti del R. Istituto Keulto, 1891–2) studied the molecular conductivity of *dilute* solutions of some alkaline salts in mixtures of glycerine and water. The present work, in which the conductivity was determined for *strong* solutions of caustic soda and potash in glycerine of fixed strength (96 per cent. glycerine, 4 per cent. water) is an amplification of Monti's work. The conductivity was determined by the telephone method at temperatures of 14°, 18°, 24°, and 80° for sodium hydrate solutions from 0·38 per cent. to 18·4 per cent. and for potash solutions from 0·47 to 16 per cent. strength. From the results it appears that (1) in glycerine, as in aqueous solutions, we find maxima of conductivity. In the case of the glycerine solutions the ratio of the concentrations corresponding to the maxima is equal to the ratio of the molecular weights of potash and soda. (2) The conductivity in glycerine solution is much less than in aqueous solution; thus the maximum conductivities of potash and soda in glycerine solution are less than the millionth part of the conductivities in aqueous solution. (3) The temperature coefficient is much larger for glycerine than for aqueous solutions. D. H. J.

2428. *Calorimetric Properties of Ferromagnetic Bodies.* **B. Hill.** (Deutsch. Phys. Gesell., Verh. 3. 10. pp. 113–118, 1901.)—Certain alloys of iron and nickel, which become non-magnetic when heated, and can be cooled to ordinary temperatures without returning to the magnetic condition, allow of the comparison of the two allotropic modifications at the same temperature. The author makes this comparison, in the first place, for certain specimens of nickel steel as regards their specific heats. The specific heat in the non-magnetic state is always greater than in the magnetic state, the difference, as a rule, diminishing with increase of temperature. The properties of one specimen made possible the determination of its latent heat of conversion. So also in the case of iron, the greater the magnetic susceptibility of a specimen the less is its specific heat, in accordance with the theory that iron ordinarily consists of a mixture of two modifications—one magnetic, the other non-magnetic. W. E. T.

2429. *Chemical Equilibrium.* **O. Boudouard.** (Annal. Chim. Phys. 24. pp. 5–85, Sept., 1901.)—The author gives an account of extensive series of experiments on the reaction $2CO = CO_2 + C$ and its inverse. The decomposition of CO in the presence of metallic oxides is a function of the time and temperature, the quantity of CO_2 formed increasing regularly up to a certain limit, and the rapidity of the reaction being a function of the surfaces of the oxide exposed. Similarly the decomposition of CO_2 in presence of carbon is a function of the time and temperature, the limit of the reaction being, for the same temperature, the same as in the inverse reaction. The numerical results obtained afford a verification of the formula due to Le Chatelier [see Abstract No. 661 (1901)], the value $-21·4$ being found for the constant involved in it. The influences of temperature and pressure on the reactions are in accordance with the general law of "the opposition of action and reaction" enunciated by Le Chatelier (Ann. d. Mines, 8. 13. p. 157). Important practical applications of the results obtained are pointed out. In conclusion the author discusses the action of the metallic oxides and the carbon in the decompositions in question, and considers that they play a part analogous to that of porous bodies which are able to absorb gases with considerable evolution of heat. W. E. T.

2430. *Possible Significance of Changing Atomic Volume.* **T. W. Richards.** (Amer. Acad., Proc. 37. pp. 3–17, June, 1901.)—A theoretical paper which does not admit of brief abstraction. Tables are given of the increase or diminution of volume occurring when metals form oxides, chlorides, or hydroxides, in connection with physical changes, expressed in terms of internal stress. An atom is conceived as "a compressible field of force possessing two attractive attributes, chemical affinity and gravitation, both of which are concerned in chemical action." It is pointed out that changing atomic volume may be used as an approximate measure of the pressure which causes it, and therefore of the affinity which causes the pressure. Some of the difficulties in the way of exact interpretation are indicated, and hints as to possible modes of overcoming them. The chief outcome of the paper is the following postulate: "The atomic volume is not constant, but a function of pressure and temperature, and probably of electrical stress, while chemical affinity is possibly a function of mass." A modification of the atomic theory is tentatively proposed which contends that "we have no right to disregard the compressible environments around the centres of gravity and affinity." S. R.

2431. *Vapour Tension of Solutions.* **A. Ponsot.** (Comptes Rendus, 133. pp. 341–344, Aug. 5, 1901.)—Experimental results lead to the conclusion that, in general, if the substitution of a body A for a body B in the compound BC, dissolved in a liquid which does not take part in the reaction, produces heat, the vapour tension of the solvent is greater when it contains a given mass of AC than when it contains an equivalent mass of BC. Measurements of the lowering of freezing-points of solutions confirm the above conclusion and lead to the more general law that, when the substitution of one radical for another produces heat, the osmotic and other moduli of the first are smaller than those of the second. J. E.-M.

2432. *Iron and Steel from the Point of View of the Phase-Doctrine.* **H. J. v. Jonstorff.** (Electro-Chemist, 1. pp. 173–174, July, 1901. Paper read before the Iron and Steel Institute, May, 1901.)—A summary is given of the results obtained by various experimenters on the solubility of carbon in solid iron during cementation at different temperatures. Attention is specially called to some experiments made by Saniter, which show that at 900° C. the action probably occurs in two stages, only martensite and cementite appearing during the first fourteen hours' heating, but graphite being subsequently formed. It is therefore suggested that at 1,000° C. the iron at first absorbs the carbon with the formation of martensite (mixed crystals of iron and carbon), and that when the iron is saturated with carbon the carbon is deposited in the form of cementite (Fe_3C) and not as graphite, the graphite only appearing locally on the surface of the metal where the whole of the iron has been turned into cementite by the absorption of 6·67 per cent. of carbon. Above 1,000° C., however, there can exist no doubt that graphite has a greater stability than cementite, and that at the higher temperatures the reverse change of cementite into graphite and martensite would take place. T. M. L.

2433. *Deposition of Copper from Various Electrolytes.* **A. A. Beadle.** (Electro-Chemist, 1. pp. 168–169, July, 1901.)—Electrolytes other than copper sulphate are here considered for the purpose of studying the structure of the deposit under varying conditions. Experiments were made with the following solutions :—

Solution.	Composition.	Grs. of Cu per litre of sol.	Sp. resist. in ohms per c.c.
A	Copper sulphate acidified with H_2SO_4	258	2·2
B	Copper nitrate acidified with HNO_3	352	2·2
C	Copper potassio-cyanide with excess of KCN....................	47	3·66
D	Cupric acetate acidified with acetic acid	5	45·0
F	Copper am.-sulphate acidified with H_2SO_4	41	1·22

Current densities varying from 10–320 amperes per square foot were employed, and the same current allowed to pass till decided signs of irregularity, such as sponginess, nodules, or spikes, appeared. Soluble anodes were employed.

The author finds that the safe rate of deposit is roughly proportionate to the amount of copper in solution. O. J. S.

2434. *Preparation of Osmotic Membranes by Electrolysis.* **H. N. Morse** and **D. W. Horn.** (Chem. News, 84. pp. 104–105, Aug. 30, 1901. From the Amer. Chem. Journ. 26. No. 1.)—The authors find that strong semi-permeable membranes of copper ferrocyanide may be formed in the walls of porous cells by means of electrolytic deposition. The air is first removed from the walls of the cell by placing the latter in a beaker, and filling both the cell and beaker nearly to the top of the former with a boiled solution of 0·5 grm. of potassium sulphate in a litre of water; on passing a current from the outside to the inside of the cell by means of electrodes dipping into the liquid, the level of the latter inside rises rapidly, and effectively sweeps out the air. After washing, the wet cup is placed in a beaker surrounded with an electrode of sheet copper completely encircling it, a platinum electrode being placed inside the cell. The electrodes are connected with the current generator, so that the current flows the moment the liquids are added; the latter consist of N/10 or N/5 copper sulphate solution for the outside, and N/10 or N/5 potassium ferrocyanide solution for the inside of the cell, and these are added as nearly simultaneously as possible. At first, considerable endosmose occurs in the direction of the current, that is, from the copper solution to the ferrocyanide, but no copper or ferrocyanide traverse the cell walls. The membrane soon begins to form, the resistance at the same time rising rapidly. Membranes thus formed are found to resist pressures of 4·5 atmospheres and possibly more. T. H. P.

2435. *Colour of the Ions.* **G. Vaillant.** (Comptes Rendus, 133. pp. 366–368, Aug. 12, 1901.)—By means of spectro-photometric measurements of solutions of the permanganates of potassium, barium, and zinc, the author experimentally confirms the following conclusions drawn by applying the ionic hypothesis to the colouration of solutions : (1) In solutions of salts which are completely ionised, and which contain only one coloured ion, the colour is independent of the nature of the other ion. (2) If the ionisation is incomplete, the colouration varies with the nature of the non-coloured ion. (3) In the general case, the equation connecting the colouration of an equation of a solution of any concentration with its degree of ionisation contains two constants, one characterising the unionised, and the other the ionised molecule. T. H. P.

2436. *Theory of the Aluminium Rectifier.* **W. Mitkiewicz.** (Phys. Zeitschr. 2. pp. 747–750, Sept. 28, 1901.)—The author has arrived at the conclusion that when an aluminium valve is in action, the surface of the aluminium electrode is divided from the liquid by an insulating layer of aluminium oxide, or by some other compound of aluminium, formed by electrolysis. The passage of the current is only made possible by the circumstance that there are many gaps in the insulating layer, which only allow the current to pass in one direction. This view is confirmed by the fact that a microscopic examination of the luminous electrode separates it into a large number of luminous points. The rectifier consists practically of an immense number of Wehnelt interrupters mounted in parallel. E. E. F.

2437. *Electrochemical Deposition.* **H. Boilbet.** (International Electrical Congress at Paris, Reports, pp. 303–305, 1901.)—In this paper the author refers to the extensive mechanical reproduction of medals and other works of art by pantographic methods, from a large-sized model reproduced in elctrolytic copper from the original. Owing to the softness of electrolytic copper, it is necessary, in order to prevent damage to the model from the pantograph stylus, to electroplate it with nickel. The author suggests that experiments should be made as to whether chromium could with advantage be electrically deposited on the copper in the place of nickel. He then suggests that it would be interesting to know if any successful attempts have been made in the direction of electroplating silver and gold directly upon aluminium. G. W. de T.

2438. *Electric Copper Refining.* **G. E. Walsh.** (Elect. Rev. N.Y. 39. pp. 213–214, Aug. 24, 1901.)—After remarking upon the progress of the copper industry, and dealing with the outputs of various mines, the author proceeds to deal with the efficiency and economy of the different electrolytic processes now in vogue.

When the electrolytic process was first attempted, the cost of producing refined copper by this method was as high as $80 per ton, and even eight years ago the charge was $20. This has now come down to $8 and $10 per ton. From the mines to the refinery the copper is in crude bars or cakes, which are tested first as to quality and value, and then heated in a reverberatory furnace, and prepared for the electrolytic bath in the form of anodes. In each tank of the refinery there are about 20 to 25 anodes and 25 kathodes, a free circulation being kept up between the tanks. An overflow pipe keeps the tanks properly filled, new fluid entering as fast as the other is drawn off.

The electrolyte contains in solution 16 per cent. bluestone and 5 per cent. sulphuric acid; the average current required for a refinery is about 10 amperes per square foot, counting both sides of the anode plate. The impurities, containing gold and silver, are deposited at the bottom of the tanks in the form of a black mud, which is afterwards screened, and treated for the recovery of its contents.

The cost of maintaining a plant at the highest efficiency has been found to be greater in the series process than in the multiple, but the former saves some loss of energy. It is estimated by modern refiners that there is a saving of nearly $2 per ton of refined copper in the multiple system. In some mining regions, where the refinery is a part of a converting establishment, and run in conjunction with it, the saving has been as much as $3·50 per ton. The average current efficiency of the multiple process is 95 per cent., as against 90 per cent. for the series process, under similar conditions. Where the electric power is expensive, or fuel high-priced, the difference in the current efficiency of the two processes must always decide in favour of the multiple process.

J. L. F. V.

2439. *Electric Furnaces.* **G. Richard.** (Écl. Électr. 28. pp. 229–236, Aug. 17, 1901.)—An illustrated account is given of W. Borchers' electric furnaces of the incandescent and arc types, in which the waste heat is utilised by means of water-jackets, and in which the waste gases are filtered through a layer of porous charcoal, so that, being free from dust, they can be utilised outside the furnace; the application is described of the same principle to furnaces in which calcium carbide, as it is produced, falls from between the electrodes, and, solidifying, forms a continuous solid cake which sinks into a bed of charcoal powder, where fragments are from time to time broken off at the lower end to make way for the fresh carbide which is constantly being added above. There are also described and figured: The resistance-furnace of Gin and Leleux; the arrangement of Roesler and Carlson in which it is sought to prevent excessive local heating by using several small electrodes in place of one large one; the arc-furnace of Contardo, in which the arc passes between horizontal electrodes placed on the hearth of a reverberatory furnace, to which the charge is fed through channels in the cover of the furnace, and is traversed by the escaping waste gases, and therefore heated both by these gases and by radiation from the furnace; the furnace of the Société Electrochimique Volta (of Geneva), which is so arranged that the portion of the charge vaporised by the arc has to pass through a portion of the charge still fluid, where it for the most part condenses, before it can escape into the air; the furnace of F. J. Machalske (see *Electrical World*, 37. p. 360, 1901) for the production of phosphorus from natural phosphates, in which it is claimed that a new silver-like metal has been produced; the rotatory furnace of F. E. Hatch (see *Electrical World*, 36. p. 548, 1900); and the glass-melting furnaces of Voeker and Luhne. W. G. M.

REFERENCES.

2440. *Concentration Changes in Edison's Accumulator.* **E. F. Roeber.** (Elect. World and Engineer, 37. pp. 1105–1108, June 29, 1901.)—The author calculates the maximum concentration changes due to the difference in ionic velocities. W. R. C.

2441. *Phase-rule.* **P. Saurel.** (Journ. Phys. Chem. 5. pp. 401–403, June, 1901.)—Wind bases his demonstration of the phase-rule [see Abstract No. 677 (1900)] on a theorem which, as is here shown, may be regarded as one way of stating the conditions of equilibrium of a system given in a former memoir [see Abstract No. 937 (1901)]. R. E. B.

2442. *A New Thermo-chemical Notation.* **J. H. Pollok.** (Roy. Dublin Soc., Proc. 9. pp. 495–505, July 6, 1901.)—A system of notation is introduced which lends itself to calculation more readily than those of Thomsen and Berthelot. T. M. L.

2443. *Polarisation Capacity of Platinum.* **E. Warburg.** (Ann. d. Physik, 6. 1. pp. 125–135, Aug., 1901.)—A mathematical paper, in which thermodynamical considerations are brought to bear on the polarisation of platinum in dilute sulphuric acid. T. H. P.

2444. *Analysis of Gases by Electricity.* **Berthelot.** (Annal. Chim. Phys. 23. pp. 433–447, Aug., 1901.)—This paper, which is chiefly of chemical interest, is a systematic summary of the effects of electric sparking on gases and on the vapours of volatile liquids. N. L.

2445. *Crystallisation of Salt Solutions.* **H. M. Dawson.** (Nature, 64. pp. 336–338, Aug. 1, 1901.)—This paper gives a short account of the principles involved, and the methods employed, in the solution of the problems connected with the crystallisation of salt solutions, as exemplified in van't Hoff's researches on the formation of oceanic salt deposits. [See Abstracts Nos. 226, 1114, 1116, 1879 (1900) and 528, 665, 933, 1538 (1901).] N. L.

2446. *Moissan's Researches on Fluorine and the Fluorine Compounds.* **H. F. Keller.** (Frank. Inst., Journ. 152. pp. 123–140, Aug., 1901.)—This paper, which is chiefly of chemical interest, gives a useful summary of Moissan's work on fluorine; ten illustrations of apparatus are given. [See also Abstract No. 2072 (1900).] N. L.

2447. *Density of Copper-Tin, Copper-Zinc, and Tin-Zinc Alloys.* **E. Maey.** (Zeitschr. Phys. Chem. 38. pp. 289–291, Sept. 17, 1901.)—Alloys of varying composition were prepared and their densities determined; the results are given in tabular form, and are compared with those obtained by Riche and Mallet. N. L.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

2448. *Speed Variation of Compound Engine.* **W. L. Abbott.** (Eng. Record, 44. pp. 155–158, Aug. 17, 1901. From the "Technograph.")—The object of the investigation is to determine the maximum angular displacement which can be produced between the armatures of two dynamos, driven by two separate steam engines at the same average speed, owing to the cyclical variation in the speed of the engines. Considering one engine, the author plots the combined crank-effort diagram from the indicator cards of the two cylinders, and, by a system of tabulation and correction, obtains successively diagrams of the deviation of velocity and of displacement, from the values they would have if the rotation were perfectly uniform; the maximum ordinate of the latter diagram is the value sought. [The deviation of crank-effort from the mean is of course a curve of accelerations on a displacement base, and from this the curves for the deviation of velocity and displacement might be found graphically.] Diagrams and a description of the calculations are given. H. R. C.

2449. *Furnace Temperatures.* **W. H. Booth.** (Elect. Rev. 49. pp. 338–340, Aug. 30, 1901.)—To illustrate the actions taking place in the combustion of solid fuel, and the need of refractory furnaces for that process, the following average of eighteen analyses of Newcastle coal is taken as a basis:—Fixed carbon 48·84 per cent.; volatile carbon 33·29 per cent.; hydrogen 5·31 per cent.; oxygen 5·69 per cent.; nitrogen 1·35 per cent.; sulphur 1·24 per cent.; ash 3·77 per cent. Calorific capacity of the coal 15,208 B.Th.U. The calorific capacity of amorphous carbon being about 14,647 B.Th.U., that of the fixed carbon in the above coal must be 7,150 B.Th.U., which represents the heat available for transforming solid coal into gaseous hydrocarbons. The 18 lbs. of air per lb. of coal, generally supplied for combustion, must also be heated by it to the temperature of combustion, and the ash and escaping gases also carry away some of the heat. The flame temperature of carbon with the minimum quantity of air (11·6 lbs.) being 4,892° F., that of 1 lb. of the coal with 18 lbs. of air will be $12·6/19 \times 4,892 = 3,243$° F. The 48·84 per cent. carbon will therefore produce $3,243 \times 0·4884 = 1,584$° F. This maximum will be reduced in proportion to the different specific heats of the gases in the products of combustion; these being: nitrogen 0·244; carbonic acid 0·217; steam 0·480; hydrogen 3·410; olefiant gas 0·418; marsh gas 0·593. These specific heats vary at high temperatures, generally increasing with increase of temperature. In addition, the latent heat of evaporation of carbon, hydrogen, and oxygen from the solid must be considered. Assuming 7,000 heat units as the latent heat per lb. for all the volatile constituents of the coal, then $0·474 \times 7,000 = 3,318$ units will be absorbed in gasification. This being deducted from the 7,150 total heat units found above, leaves 3,832 available heat units. If the gases were collected unburned, the temperature produced by the fire would have to be below their ignition-point. If half the air supply were sent through the fixed carbon and the other half supplied to the evolved gases at a later period, that temperature would be doubled. Hence the necessity for regulating the air supply. Brick-lined furnaces are necessary to conserve the radiant heat from the incandescent carbon. The following figures are given :—

HEAT GENERATED BY THE COMBUSTION OF 1 LB. OF CARBON IN DIFFERENT STATES.

State of Carbon.	Product of Combustion.	B.Th.U. per lb.
Diamond	Carbon monoxide	8,915
„	„ dioxide	14,146
Graphite	„ „	14,222
Amorphous	„ monoxide	4,415
„	„ dioxide	14,647
Gaseous	„ monoxide	10,732
„	„ dioxide	20,963
Carbon monoxide	„ „	10,231

Metamorphic Conversions.		Heat absorbed.
Carbon (diamond)	to gas	6,816
„ (graphite)	to „	6,241
„ (amorphous)	to „	5,817
„ (diamond)	to carbon amorphous	499
„ (diamond)	to „ graphite	74·7
„ (graphite)	to „ amorphous	424

About half the weight of bituminous coal burns on the grate, and produces half the total heat of combustion ; but the vaporisation of the solid fuel absorbs so much heat that only one-fourth is found as sensible heat. The remaining three-fourths are developed between the fuel surface and the extreme range of combustion. Anthracite burns entirely as solid carbon, and hence the high local temperature at the grate bars. The chilling effect of fresh charges of fuel is much less with anthracite than with bituminous coal. Furnace temperatures are always lower than ordinary calculations make them, and many boiler furnaces cause additional loss by interposing very active heat-absorbing surfaces too close to the surface of the fire, thus preventing the proper ignition of the combustible gases. F. J. R.

2450. *Furnace Temperatures.* **C. C. Garrard.** (Elect. Rev. 49. pp. 382–383, Sept. 6, 1901.)—The author takes exception to W. H. Booth's term the "evaporation of carbon" [see preceding Abstract], holding that whilst such an action may occur in the electric furnace it does not exist in ordinary fuel furnaces. What was probably meant by Booth was the latent heat of vaporisation of the volatile hydrocarbons already existing in the coal, and therefore the proper way of arriving at the loss of heat at the grate by vaporisation of these compounds is to fractionate the coal, and calculate the result from the analysis and known latent heats of the constituents. As to the "latent heat of the vaporisation of carbon" being equal to the difference in the heat of combustion of carbon burned to its monoxide and that of the monoxide burned to dioxide respectively, the methods of combination of the two oxygen atoms in the CO_2 molecule are not necessarily identical, nor can it be proved that they enter into combination with the vaporised carbon with exactly the same liberation of energy. This writer remarks that Booth neglects the effect of dissociation on the maximum temperature obtainable in a furnace, and shows by calculation that Booth's maximum 4,892° F. should be 4,172° F. Although this affects all his calculations it rather accentuates Booth's point as to the low temperature of the furnace, but this writer considers that pre-heating the air supply by the waste heat is the rational way of overcoming the difficulties alluded to by Booth. F. J. R.

GAS AND OIL ENGINES.

2451. *Gas Plants for Engines.* **J. E. Dowson.** (Inst. Civil Engin., Proc. 144. pp. 269–285, June, 1901.)—The author deals first with various points connected with the practical working and testing of gas plants. Referring to some tests made by Meyer, in which the quality of gas was found to vary with the rate of production, he states that, with an anthracite fire, the maximum production can be reduced 80 per cent. in a small generator, and 50 per cent. in a large one, without appreciably affecting the quality of the gas. In small generators fuel should be fed in frequently in small quantities; in large generators longer intervals may be allowed. When non-bituminous fuels are used, the introduction of fresh fuel does not affect the quality of gas, if the depth of fire be sufficient. The author does not advocate automatic stokers. The gas should have a calorific value of at least 1,200 calories per cubic metre, and should contain not less than 15 per cent. of hydrogen, to insure prompt ignition.

Describing the various types of gas-plant the author divides them into three classes:—

(1) Producer with jet of superheated steam, forcing in air, *e.g.*, the Dowson plant.

(2) Producer without steam-jet, and with blower to force in air, *e.g.*, the Lencauchez and Mond plants.

(3) Producer without steam-jet or blower, the air being drawn in by a suction pump attached to the gas engine, *e.g.*, the Bénier plant.

In the Dowson plant about 90 per cent. of the steam is decomposed, and, under best conditions, ¾ lb. per lb. of anthracite consumed.

The percentage of hydrogen in the gas should be as large as possible, provided that not more than 6 per cent. of carbon dioxide be present. In an Appendix are given results of ten tests of Dowson gas plants. The average calorific power of the gas is 1,432 calories per cubic metre, and the average heat efficiency 78·9 per cent. The author distributes the loss of heat for 80 per cent. efficiency as follows:—

Loss in boiler	7 per cent.
Undecomposed steam	1 „
Unburnt anthracite	2 „
Loss in radiation and cooling of gas	10 „
	20 „

In the Lencauchez plant there is no boiler, and air, saturated with moisture, is forced into the generator by a blower, driven by hand at starting, and afterwards by the engine. No complete tests of the plant are available.

In the Mond plant [see Abstract No. 1567 (1901)] the calorific value of the gas is 1,385 calories per cubic metre, and the heat efficiency 79 per cent.

In the Bénier plant air is drawn into the generator by a suction-pump attached to the engine, and, as the quantity drawn in varies with the gas consumption, no gas-holder is needed, but each engine must have its own generator. Water is vaporised in the fire-grate, and mixes with the air before entering the fuel column. A test by Witz showed a calorific value of 1,149 calories per cubic metre. G. H. B.

AUTOMOBILISM.[1]

2452. *Motor Cycles.* **A. L. Clough.** (Horseless Age, 8. pp. 395–396, Aug. 7, 1901.)—Tricycles, being three-track vehicles, cannot go fast with comfort over ordinary roads. For motors, bicycles are therefore preferable. The motor should not be rigidly geared to the cycle, but preferably belted, to prevent the more sudden stresses on wheels and tires due to the power stroke of the motor at low speeds. The motor shaft and secondary shaft must have oil-tight bearings, or oil will get on to the contact-breaker and on to the belt pulley. A practical form of spring-supported motor is needed, to obviate the large dead load which the motor puts on a rigid construction, originally developed solely for carrying a live load. The front fork is severely strained by a rigid motor. For the same reason the stresses on tires are more severe, owing to the dead load, than in a tandem bicycle. Means for adjusting the tension of the driving belt from the saddle are desirable, forming a crude free clutch and low gear. E. H. C.-H.

2453. *Kuhlstein-Vollmer Vehicle.* (Horseless Age, 8. pp. 402–403, Aug. 7; and 462–463, Aug. 28, 1901. From the *Motorwagen.*)—In this car an underframe of rectangular channel iron carries a horizontal petrol engine towards its back end, with the crank chamber nearly over the rear axle of the car, and the cylinders in front. The latter are parallel, and the bodies are formed in one casting, which is bolted to the crank chamber. The pistons are coupled to cranks at 180°. The cylinder dimensions are 4·8 in. bore by 5·6 in. stroke, and the engine is rated at 9–10 b.h.p. The suction valves are automatic, and the exhaust valves are mechanically operated; they are placed in independent pockets, opening into the combustion chambers. The power is transmitted from one end of the crank-shaft, first by a short belt to a counter-shaft, pivoted in such a manner that the tension of the belt can be varied at will by the driver. The pivots of this shaft are concentric with the first motion shaft of the change-speed gear, which is driven from it by spur gearing. The change-speed gear is of the spur-wheel type, with teeth engaging by side contact. The second motion shaft of the change gear carries the differential gear, and the road wheels are driven from it by chain gears at either end. Three speeds forward, and one reverse, are obtained by the change gear, and the belt serves the purpose of a friction-clutch. A plan and elevation of the car mechanism, and details of the engine are given. C. R. D'E.

2454. *Mercedes Carriage.* (Horseless Age, 8. pp. 431–432, Aug. 21, 1901.)—This is a powerful car, built with the centre of gravity as low as is practicable without bringing the mechanism dangerously near the road surface, and intended for general touring purposes. The engine is of the four-cylinder "Daimler" type, and is mounted near the front of the underframe. It is covered by a rectangular bonnet, which, at its front end, fits around the combined water-tank and radiator. This tank is 8 inches deep, and is honeycombed with small tubes from front to back. Behind the tank is a fan, driven by gearing from the engine shaft, so that a definite volume of air is sucked through the cooling pipes, irrespective of the speed of the car. The exposed surface of the air-pipes is very large, and the quantity of water carried, 1·5 gallons, is much less than is required with other forms of coolers. The water is circulated by a centrifugal pump. The engine is fitted with low-tension electric ignition supplied with current by a magneto machine. The power is transmitted to the change-speed gear through an expanding clutch, which forms part of the engine flywheel. The change gear is of the spur-wheel type, in which the wheels are engaged by side contact, and gives four forward speeds and one reverse. The transmission from the change gear is first by a bevel drive to the differential cross-shaft, and then by chain drives to the road wheels. Three powerful brakes are provided. An illustration is given of a 35-h.p. Mercedes car built on similar lines to the 16-h.p. vehicle.

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[1] Electric automobiles are described in the section dealing with electric traction.

C. R. D'E.

2455. *Musker Coke and Oil Fired Waggons.* (Automotor Journal, 5. pp. 518–525, Aug. 1901.) [See also Abstract No. 943 (1901).]—This paper gives an illustrated description of both types. In the former the boiler is placed in the extreme front, and is of the vertical Serpollet tube type, designed to generate superheated steam at 225 lbs. working pressure. The tubes are in concentric coils, and have an area of 70 square feet, with a grate area of 2·5 square feet. Coke is fed in through a hopper in the top of the boiler casing. Both a steam-jet and a centrifugal fan are employed for producing a forced draught. The engine has four horizontal cylinders, and is mounted a little in front of the back axle. Transmission is by spur gear to a countershaft parallel with the axle, and from this by internal spur gears to the road wheels.

The oil-fired waggon is constructed on much the same lines, except that the boiler is horizontal, and placed below the waggon platform. It is of the same type as the coke-fired boiler, but the supply of oil, water, and forced draught is obtained from a separate engine. In both waggons the wheel base is 10 feet, and gauge 5 ft. 7 in. The steering-wheels are 3 feet in diameter, with 5-inch iron tyres; the driving wheels 3 ft. 8½ in. in diameter, with 6-inch tyres. C. R. D'E.

2456. *Motor Reaping Machine.* **G. Coupan.** (Génie Civil, 39. pp. 281–283, Aug. 31, 1901.)—This is a self-propelled field reaper, in which a petrol motor is employed to give motion both to the cutting-blades and to the vehicle itself. It consists of a three-wheeled truck, steered by the front wheel and driven by the rear wheels. The engine has two horizontal cylinders mounted nearly opposite one another, with pistons coupled to cranks at 180° on a transverse shaft lying between the cylinders. The engine is placed longitudinally between the axles of the truck, and the operator sits somewhat behind the rear axle, much as in a horse-drawn reaper. Below the cylinders is a long cylindrical box divided into three compartments. The central space contains the petrol supply, and the end compartments form the exhaust silencers. At one end of the crank-shaft is an overhanging flywheel, and at the other end is a bevel pinion, gearing with two bevel wheels on a downwardly inclined shaft. By means of friction clutches, either bevel gear may be caused to drive the shaft, giving motion to it for either forward or backward movements of the machine. At the lower end of the inclined shaft is a bevel pinion, engaging with a bevel wheel on a horizontal shaft parallel with the length of the machine. From the back end of the horizontal shaft, motion is imparted to the driving axle through both a bevel and a spur drive, and at its front end an eccentric pin gives a reciprocating motion to the reaper blades. Suitable means are provided for driving either the reaper blades alone or propelling the machine alone. Several good illustrations of the mechanism are given. C. R. D'E.

2457. *Santos-Dumont Navigable Balloon.* (Engineer, 92. pp. 89–91, July 26, 1901.)—A general account of M. Santos-Dumont's experiments with navigable balloons is given, together with some details of his most successful air-ship. The balloon of the latter is of cigar shape, 34 m. long and 5·6 m. in central diameter, and has a capacity of 550 cubic metres. From it is suspended a triangular-shaped frame about two-thirds the length of the balloon, and constructed of pitch-pine laths stayed by steel wires. A 16-h.p. four-cylinder Buchet petrol motor is slung from the frame near the centre of its length, and drives, by a spur gear, a long tail shaft which carries at its far end a two-bladed propeller. The speed of the engine is about 2,000 r.p.m., and that of the propeller-shaft about 200 r.p.m.; the blades of the propeller are each 2 m. long. A three-cornered sail mounted over the propeller end of the frame is used for steering. The weight of the balloon is 150 kilos., and that of the rest of the apparatus 210 kilos. The speed attained in still air is about 11 m. per sec. Photographs are given showing the complete air-ship and the motor, together with a portion of the frame. C. R. D'E.

2458. *Brennan Engine.* (Horseless Age, 8. pp. 318, July 3, 1901.)—This is a horizontal petrol engine with cylinders mounted on opposite sides of an oil-tight crank chamber, and pistons coupled to cranks at 180°. The cylinders are of 3·25-inch bore × 4-inch stroke, and are water cooled. The body and head of each cylinder are made in one casting, so that there is no danger of leakage of water into the combustion chamber. The suction and exhaust valves work horizontally, and both open into the same valve box. The engine is rated at 5·5 b.h.p. at 1,400 r.p.m. A part sectional plan is given. C. R. D'E.

2459. *Sturtevant Carburettor.* (Locomotion Automobile, 8. pp. 488–489, Aug. 1, 1901.)—In this carburettor the surface of a metal drum, which rotates within a closed box, is kept moist by contact with an absorbent packing saturated with petrol. Air sucked in by the engine passes over the surface of the drum, and in this manner becomes carburetted. The richness of the carburetted mixture may be varied by varying the speed of rotation of the drum. C. R. D'E.

2460. *Le Croissant Electric Ignition.* (Locomotion Automobile, 8. pp. 550–551, Aug. 29, 1901.)—In this apparatus a combined magneto generator and induction coil is employed in conjunction with the ordinary form of high-tension sparking plug on the engine. The magneto has a permanent magnet field in the form of a ring with two projecting poles. Within the ring rotates an electromagnet having two coils at 180°, each coil consisting of a primary and a secondary winding. The primary coils are normally short-circuited, but once in each revolution the circuit is broken by means of a cam switch on the armature spindle. At the same time a second rotary switch establishes connection between the high-tension end of the secondary and the insulated terminal of the sparking plug, the low-tension end of the secondary being always connected to earth. The charge in the motor cylinder is fired by the discharge between the points of the plug. The instant of ignition, relative to the position of the piston, may be varied by displacing the field magnet poles relatively to the armature. A diagram of the apparatus is given, and also a photograph showing its application to a motor tricycle. C. R. D'E.

2461. *Heymann Variable Transmission Gear.* (Horseless Age, 8. pp. 452–453, Aug. 28, 1901.)—In this gear the driving shaft has mounted upon it three eccentrics, arranged at 120° with each other, and so mounted that the throw of each can be varied between definite limits. These eccentrics drive a parallel shaft through roller clutches, which drive normally in one direction only, but may be caused to drive in the reverse direction. The angular movement of the driven shaft, per revolution of the driving shaft, is variable according to the eccentricity of the eccentrics. A photograph of the gear is given. C. R. D'E.

2462. *Brakes for Automobiles.* **A. Petot.** (Comptes Rendus, 133. pp. 410–412, Aug. 26, 1901.)—The author considers that in calculating the retardation produced by brakes, it is unnecessary to take into consideration the effect of the *vis viva* of rotating masses, such, for instance, as armatures on electric automobiles. The work which has to be done by the brakes is undoubtedly increased by the action of the rotating masses, but at the same time the pressure which can be applied by the brakes without causing skidding is similarly increased. The result is that the rate of retardation is the same as if the existence of the rotating masses were neglected. W. H. S.

REFERENCES.

2463. *Alcohol for Automobiles.* **L. Guillet.** (Locomotion Automobile, 8. pp. 465–466, July 25, and pp. 481–482, Aug. 1, 1901.)—These papers contain a review of the possibilities of alcohol as a substitute for petrol in internal combustion engines. C. R. D'E.

2464. *Automobile Trials at Glasgow.* (Automotor Journal, 5. pp. 559–577, Sept. 1901.)—Judges' awards and descriptions of competing vehicles.

GENERAL ELECTRICAL ENGINEERING.

2465. *Temperature Increase of Accumulator Capacity.* **C. Heim.** (Elektrotechn. Zeitschr. 22. pp. 811–815, Sept. 26, 1901. Abstract of a paper read at the ninth annual meeting of the Verband Deutsch. Elektrotechn. at Dresden.)—The author confirms his previous observations of the increase of capacity of storage cells with rise of temperature [see Abstract No. 220 (1901)]. He has experimented with Hagen cells of 69 and 482 ampere-hours capacity. In the case of the smaller cells, heating was effected by a leaden worm, having hot water circulating through it, placed under the cell. The larger cells, which were in lead-lined boxes, were heated by gas-burners placed directly beneath them. To prevent loss of heat a felt jacket was placed round the cells. The result of the new experiments show that the influence of temperature on capacity is very marked. This result may be of practical importance if a rise of temperature does not injure the plates. W. W. H. G.

2466. *Discharge of Accumulators.* **S. A. Montel.** (Centralblatt Accumulatoren, 2. pp. 283–285, Sept. 1, 1901.)—A mathematical investigation of the relation between capacity and discharge current leads to the formula—

$$C = \frac{\gamma}{1 + \alpha I},$$

where C is the capacity, I the current, α and γ constants. This corresponds with the empirical formula of Liebenow. W. W. H. G.

2467. *Puncture Resistance oj Insulators.* **C. Baur.** (Electrician, 47. pp. 758–759, Sept. 6, 1901.)—The curves relating to cables insulated with impregnated jute for thicknesses d of the insulation from 2 to 24 mm., and the corresponding potential V, can be represented by the formula $V = Cd^{\frac{2}{3}}$. The same formula was applied to curves representing a test made upon impregnated calico, measured between plain surfaces. Not only was the formula for the curve the same, but the constant was the same. For air, similar results with a different constant were obtained. O'Gorman [see Abstract No. 1574 (1901)] suggests a constant volt-resisting quality per centimetre, quoting Trowbridge and Gray, but the author finds that the puncture distances for 7, 8, 9, and 10 mm. are proportional to the numbers 52, 50, 48, 47. The curves quoted in O'Gorman's paper for Fuller board and empire cloth are also brought to agree, and a law is enunciated as follows: Every dielectric, whatever its thickness, requires a certain voltage to break it, and this is proportional to the two-thirds power of its thickness. Electrical breaking strengths, *i.e.*, p.d.'s necessary to break a thickness of 1 mm., are tabulated from this law as follows:—

Impregnated jute	2,200	volts.
Impregnated calico	2,200	„
Dry ordinary air	3,300	„
Vulcanised indiarubber of good quality	10,000	„
Empire cloth	12,500	„
Fuller board	19,000	„
Mica	58,000	„

M. O'G.

2468. *Design of Switch Gear.* **W. E. Warrilow.** (Elect. Rev. 49. pp. 381–382, Sept. 6; and 422–423, Sept. 13, 1901.)—The author points out that, with boilers or generating plant, breakdowns are generally confined to the units themselves; whereas with a switchboard a breakdown, such as a fire, may mean the total interruption of supply. It is therefore most necessary that every attention should be given to switchboard design, especially for the large power schemes which are now coming forward. A number of details in connection with high- and low-tension switchboards are given, and the author appears to come to the conclusion that the best solution is to be found in the pigeon-hole type of board, with no connections at the rear. E. K. S.

2469. *Lead Burning with Compressed Oxygen and Hydrogen.* **L. Michaelis.** (Zeitschr. Elektrotechn., Wien, 19. pp. 460–461, Sept. 22, 1901.)—After pointing out the danger of using certain types of oxy-hydrogen blowpipes, the author strongly recommends the safety burner made by the firm of H. Dräger of Lübeck [see also Abstracts Nos. 2484 (1900) and 1777 (1901)]. W. W. H. G.

2470. *Automatic Transformer Switches and their Effect on the Efficiency of Alternate-Current Systems.* **J. F. Weyde.** (Zeitschr. Elektrotechn., Wien, 19. pp. 441–445, Sept. 15, and 458–460, Sept. 22, 1901.)—After a general discussion of the house-to-house and substation systems of distribution, the author shows that a marked reduction in the all-day losses can only be effected by the adoption of automatic switches for throwing transformers into or out of circuit. He lays down the conditions which must be fulfilled by a satisfactory transformer switch thus: (1) the switch must be perfectly automatic in its action; (2) it must be capable of being applied to existing systems of distribution without necessitating any changes in the wiring on the consumer's premises, or in any way inconveniencing or hampering the latter in the use of his current-consuming devices; (3) the action of the switch must depend solely on the demand for current (time-switches are excluded by this condition), in order to secure the highest degree of economy; (4) the switch must be absolutely reliable, must absorb a negligible amount of energy, require little attention, and its first cost must be so low that, after deducting the 10 per cent. for interest and depreciation on the capital expenditure, a clear saving is still effected. The author states that out of the many automatic switching systems proposed there are only four which may be regarded as capable of being applied in practice. These are due to H. Müller; the Electric Selector and Signal Company of New York; Walton; and Schlatter. [See Abstracts Nos. 196 and 334 (1898).] The latter switch is, in the author's opinion, the only one which fulfils the conditions laid down by him. A detailed description of the switch and its mode of action is given. A. H,

REFERENCES.

2471. *Electromagnetic Mechanisms.* **S. P. Thompson.** (International Electrical Congress at Paris, Reports, pp. 201–209, 1901.)—This paper contains a discussion of the principles of classification of electromagnetic mechanisms as set forth by the author in 1887 in his treatise on the Electromagnet, and a detailed classification reproduced, with some modifications and additions, from that work. G. W. de T.

2472. *Engineering Progress.* **R. E. Crompton.** (Electrician, 47. pp. 842–845, Sept. 20, 1901.)—Presidential address, chiefly on electric traction, delivered to Section G. of the British Association at Glasgow, Sept. 12, 1901.

GENERATORS, MOTORS, AND TRANSFORMERS.

2473. *Construction and Systematic Manufacture of Alternators.* **O. Lasche.** (Engineering, 72. pp. 173–174, Aug. 9; 205–207, Aug. 16; 240–242, Aug. 23; and pp. 277–280, Aug. 30, 1901. See also Zeitschr. Vereines Deutsch. Ing. 45. July 13 and 20, 1901.)—A very closely reasoned series of articles by an engineer of the A. E. G., in which he traces the development of alternator design from the small machines of ten years ago to the largest flywheel types of to-day.

Many very interesting particulars are given, but the drift of the whole paper is to show that for large sizes of machines it is impossible to continue the old method of building up alternator armature cores inside a massive cast-iron ring.

A round body of large diameter, when brought from an horizontal to an upright position, becomes changed in form by the action of its own weight. It has therefore been found better to build the armature rings of comparatively light weight and of standard section, and to depend on tie rods arranged outside the armature ring to give the necessary stiffness.

Besides giving a better mechanical construction from the point of view of getting the armature ring into a true circle, and keeping it in that condition whatever the temperature, there are a number of contingent advantages. Thus the machine is considerably cheaper and much easier to build. There is a considerable saving in carriage because of the reduced weight, and, inasmuch as the method allows of standardisation being carried to a higher degree than heretofore, the date for delivery of any given machine can be much advanced.

To show the very great saving in weight, a comparison is made between a large Westinghouse flywheel alternator and one built up on the tie-rod system. The weights of the armature ring are approximately as follows :—

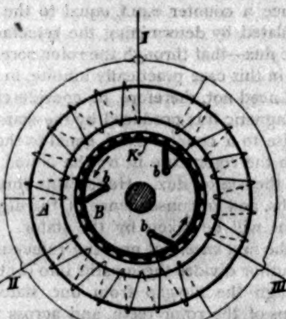
	Rigid Cast-iron Casing Tons.	Stiffened Casing. Tons.
Weight of laminated iron in the armature ...	40	40
Additional constructional weight ...	195	10
Total weight of stationary part ...	235	50

That is to say, in the first case the total weight is about six times greater than is electrically necessary. The articles are excellently illustrated. E. K. S.

2474. *The Compensation of Alternators.* **S. Woodfield.** (Elect. Rev. 49. pp. 343–345, Aug. 30, 1901.)—It is important that the terminal p.d. of alternators should be automatically so controlled as to be constant for all values of the load and for all power-factors. The usual method of compensating is to compound the alternator, the exciting coils receiving rectified current from a commutator. This method, however, fails to compensate for the demagnetising effect of the armature current when the load is inductive, and, in addition, the brushes need to be moved to the position of minimum sparking. The General Electric Company, of Schenectady, have devised a method of control which gets over these difficulties. Its application to a three-phase machine is described. The exciter is mounted on the shaft of the alternator, and has the same number of poles. In addition to being connected to the commutator, the armature winding of the exciter is connected to three slip-rings, just like an ordinary three-phase rotary converter. The slip-rings are connected to the secondary terminals of a three-phase transformer, the primary windings of which are each in a main circuit of the three-phase machine. It is shown graphically that by this means compensation for all loads and power-factors can be obtained.

A. R.

2475. *Induction Motor with a Power-Factor of Unity*. **A. Heyland.** (Elektrotechn. Zeitschr. 22. pp. 633–634, Aug. 8, 1901; see translation in Electrician, Aug. 16, 1901.)—The author describes a method of increasing the power-factor of an induction motor, which is illustrated in the accompanying sketch, and which consists in producing the rotating field by means of low-frequency rotor currents. Imagine an ordinary induction motor with a short-circuited rotor, and let the short-circuiting ring be provided with three brushes, as shown in the sketch, connected to small sections of the stator winding. The low-frequency currents led into the rotor windings through these brushes supply the necessary excitation. An ordinary squirrel-cage rotor would be unsuitable, as, on account of the low resistance of the short-circuiting ring, too much current would be shunted by it. The short-circuiting ring must have a suitable amount of resistance, and the arrangement used in practice would consist of a wound rotor, connected to a commutator whose segments are bridged over by suitable resistances, and which is therefore not liable to spark. The author states that not only may the power-factor be made equal to unity by means of this arrangement, but that the stator currents may become leading instead of lagging ones. The necessary adjustment is obtained by shifting the position of the brushes. A machine constructed on this principle will also act as a self-exciting generator, and the author expresses the opinion that such generators will be especially suitable in the case of large slow-speed machines intended for parallel running. Various machines of this type are in course of construction by the Allgemeine Elektricitäts-Gesellschaft, and by Siemens and Halske. A. H.



2476. *Graphical Theory of Synchronous Motors*. **P. M. Verhoeckx.** (Écl. Électr. 28. pp. 399–401, Sept. 14, 1901.) — The author criticises a paragraph in Blondel's paper on the graphical theory of synchronous motors [see Abstract No. 2010 (1901)]. He points out that the construction given by

Blondel to determine the wattless current of a synchronous motor working at constant power, as a function of the excitation, is not correct. A neat geometrical solution of this problem is given for the case when the armature reaction is negligible. In his reply (Ecl. Élect. 28. p. 482, Sept. 28, 1901), **Blondel** shows that the error was merely a slip in the title of the paragraph, which should read "at constant watt current," and not "at constant power."

A. R.

2477. *Calculation of Short-Circuit Current of Induction Motors.* **A. Siewert.** (Elektrotechn. Zeitschr. 22. pp. 615–620, Aug. 1, 1901.)—The method used by the author for calculating the current taken by the stator winding of an induction motor, whose rotor is short-circuited and prevented from running, is based on the following considerations:—When the rotor is open-circuited, the stator current must give rise to a magnetic flux, which is sufficient to produce a counter e.m.f. equal to the impressed p.d. This current may be calculated by determining the reluctance of the main path open to the magnetic flux—that through the rotor core. The reluctances of the leakage paths are in this case practically infinite, in comparison with that of the main path, and need not, therefore, be considered. When the rotor is short-circuited, the magnetic flux produced by the stator current must again be sufficient to give rise to a counter e.m.f. equal to the impressed p.d. But now the path through the rotor core is, by the action of the rotor currents, practically closed to the stator flux. Hence this flux has to pass entirely along the leakage paths, and in consequence of the high reluctance of these a much larger current will be taken by the stator. This current may be calculated, just as in the first case, but now the reluctance is that due to the leakage paths. The author divides these paths into (1) those across the stator slots; (2) those through the air-gap from one stator tooth to another; (3) those along the tops of the rotor teeth, and across the slits between the upper expanded portions of the teeth. A detailed calculation is given for several typical cases. The differences between the calculated and observed values of the short-circuit current amounted to from 5 to 10 per cent. A. H.

2478. *Alioth Three-phase Asynchronous Motors.* **L. Trylski.** (Écl. Électr. 28. pp. 322–325, Aug. 31, 1901.)—This is an illustrated description of one of the Alioth three-phase motors manufactured for the "Compagnie des chemins de fer de l'Ouest."

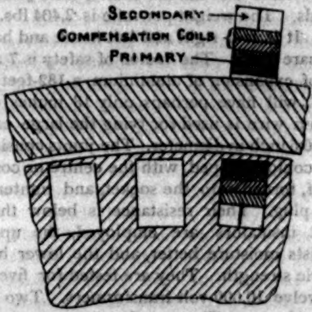
The motors can develop 500 h.p. at a speed of 100 r.p.m. The pressure is 5,000 volts, and the frequency 25. The diameter of the rotor is 2,996·5 mm., and the air-gap is 1·75 mm. all round. The stator winding is placed in 450 slots, and is composed of 225 coils placed in micanite tubes. The rotor is drum-wound, with 30 poles, the winding being placed in 720 slots.

The current taken by the motor is about 50 amperes, the efficiency is 92 per cent., the power-factor is 0·93, and the slip on full load 3 per cent.

W. G. R.

2479. *Static Transformers.* **J. Routin.** (International Electrical Congress at Paris, Reports, pp. 105–137, 1901.)—In this paper the author considers the following problem:—Given the dimensions of the magnetic framework of a transformer, and the weight of copper in the windings; to determine the effects of varying the induction upon the no-load loss, the ohmic drop in voltage, the efficiency, and the heating of the different parts. He first gives an easy mathematical proof, in the case of the two windings of a monophase transformer, of Kapp's law, that, with a given C^2R loss, the least quantity of copper will be required when the current densities are the same in the two circuits, and points out that, in addition to the economy, the fulfilment of this condition gives the advantage of distributing the losses approximately in proportion to the cooling surfaces of the two windings. He then shows that the same law holds for any number of circuits. As a special case it follows that for a given C^2R loss in any network, the greatest economy in copper is obtained when the current density is the same throughout. The author then obtains a series of curves, expressing the different quantities considered in terms of the induction, and, after showing by their aid that the best results in practice are not obtained under the theoretical conditions of maximum efficiency, he determines in the first place the relations existing between the various quantities. He then establishes the relation between the heights of the cores and the distances between them for a minimum hysteresis loss, considers the effects of varying the dimensions of the framework and of the core sections, and finally, he investigates the best form to be given to the core sections, arriving at the conclusion that the stampings should be cruciform, the arms being of equal length, and the section a maximum determined by the condition that it has to fit into the cylindrical space within the winding. Illustrations are given of transformers manufactured by Grammont to the author's design. G. W. DE T.

2480. *Rotary Converter by Leblanc.* **C. Feldmann.** (Elektrotechn. Zeitschr. 22. pp. 806–811, Sept. 26, 1901.)—The paper contains a fully illustrated description of a 60-kw. Leblanc converter [see Abstract No. 505 (1899)] for two-phase currents. It consists of a transformer whose secondary coils are connected to a stationary commutator, and a small synchronous motor for rotating the brushes inside the commutator. The core of the transformer is formed by two laminated coaxial rings, the inner one of which is furnished with 60 slots, in which the coils are arranged as shown by the sketch. The 60 secondary coils are connected to the commutator, which contains 480 segments, the segments being connected by means of cross-connectors. The compensation coils are intended to facilitate sparkless running, by supplying the wattless components of the current to a synchronous motor. An elaborate theoretical discussion of this mode of transformation is given by the author, who states that the practical results obtained with the machine described are in complete accord with theory. A. H.



ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

2481. *Pole Line Construction for High-Pressure Transmission.* **C. O. Poole.** (Journal of Electricity, S.F., 11. pp. 185–195, Aug., 1901. Paper read before the Pacific Coast Electric Transmission Association, San Jose, June, 1901.)—In this paper, which is very fully illustrated, the author gives an account of the system of pole line construction adopted by the Standard Electric Company of California. The poles are of sawn redwood without sap, and vary from 30 feet high, 7 inches square at the top and 12 inches at the base, with 5 feet below ground, up to 60 feet high, 11 inches square at the top and 17 at the base, with 8 feet below ground. In soft, marshy ground a sort of Maltese cross arrangement of redwood arms, 8 ft. × 8 in. × 2 in., is spiked on so as to come just below the surface wlth about 3 feet of turf and earth piled over it. At all angles greater than 2·5° the poles are double constructed and strutted. A truck derrick is used for erection where possible. In very bad ground from one to three piles support each pole. Where supported over water, platforms 4 feet square are built round the bases for construction and repairs. When crossing navigable streams, in order to attain the statutory height of 115 feet above high water, steel towers with redwood tops are employed. The greatest span is 618 feet, with a sag of 19 feet. The cable strains are taken on four to six insulators attached to horizontal arms shaped to the curve of the cable to divide the strain. The main line consists of three aluminium cables, each ⅞ inch in diameter, and made up of 37 strands. The weight per mile is 2,404 lbs., and the resistance per mile 0·205 ohm. It is laid right and left hand, and has a tensile strength of 28,000 lbs. per square inch. The factor of safety is 7 at 20° F. Owing to the high coefficient of expansion of aluminium, a 132-feet span, having a sag of 33 inches at 100°, will have perhaps only 13 inches on a cold morning. No. 1 solid aluminium wire is used for tying the large cables, and No. 4 for cables not exceeding 0·5 inch in diameter. The joints consist of right- and left-hand screw sockets, conical-shaped, with the centre or core wire of the cable turned back on itself, forced into the socket, and tightened by driving in a tapered aluminium plug. Their resistance is below that of the ordinary portions. Two-part insulators are employed, the upper half being of porcelain, which resists moisture better, and the lower half of glass, which has a greater dielectric strength. They are tested for five minutes at 120,000 volts, obtained by twelve 10,000-volt transformers. Two men can test thirty insulators in fifteen minutes. The transformers are connected in groups of three on the low-tension side through insulating transformers, the high-pressure terminals being all connected in series. The pressure is regulated by a rheostat connected in series with the low-tension circuit. The insulator pins are of blue gum sawn into sticks, cleared of sap by boiling, and air dried, after which they pass through a machine which completes the pin in one operation, and finally they are boiled in linseed oil. The pins are driven into the pin-holes with paint simply. A porcelain sleeve covers the base of the pin and projects up under the glass petticoat, an arrangement which prevents weathering, and protects the pin in case of an arc tending to strike from the edge of the insulator to the base of the pin. The cross-arms are of close-grained kiln-dried Oregon pine, treated with asphaltum oil under pressure at a temperature of 250° F. until thoroughly permeated. All poles carry a six-pin telephone arm placed 6½ feet below the power arm. The power line is not transposed, but the telephone wire is transposed every four poles on a single transposition insulator. Provisions are made for opening the power line at several points, in case of trouble, by means of switches contained in specially designed switch-houses. G. W. DE T.

2482. *High-Tension Switches and Fuses.* (Journal of Electricity, S.F. 11. pp. 176–180, July, 1901.)—This is a report of the discussion on the eleven papers on high-tension switch gear read before the Pacific Coast Electric Transmission Association. [See Abstract No. 1996 (1901).] **C. O. Poole** thought that extremely high-tension switching should be done in oil or water. **Masson** said that the Independent Electric Light and Power Company always made a point of opening and closing all high-tension switches when there is power on both sides of the switch, so that there is no spark. The shock or stress on the insulation of the system that is produced by a spark is a bad thing, and while it is certainly possible to make a switch that will open any circuit, provided the building is big enough or oil is used, yet it is much better to arrange the switch gear so that there is no arcing at all. No matter whether an arc is broken in air with a gap of 6 feet in a long flaring arc, or in oil with a gap of 8 inches, there still results a most serious shock to the insulation. He advocates in all cases, therefore, the closing of low-tension switches first, and then of the high tension. In illustration of his argument he described an arrangement in which two or more polyphase generators can be connected through multiple switches to a set of bus-bars, and through transformers, with multiple switches in the primary circuits, to the distributing bus-bars, these being closed first. If the generators are then connected with their bus-bars they will be held in parallel. The two machines being also held in parallel from the low-tension side, there will be no p.d. on opposite sides of the high-tension switches, which may therefore be closed or opened without any sparking. He spoke strongly against the habit of opening switches occasionally to see if they were in proper order, and he also had a good deal to say against the use of circuit-breakers, which he described as very treacherous at best. They were liable to jar out in time, and the hair triggers were altogether too delicate. If they were employed they should be triple pole (one for each phase), not single pole. **Lighthipe** confirmed Masson's remark that with plenty of head-room one could open any circuit. The oil switches on the Metropolitan Railway open very heavy circuits at 5,000 or 6,000 volts—3,000 to 4,000 amperes. Each switch is confined in a brick fireproof vault and worked pneumatically by an attendant standing about 80 feet away. The arcing of a switch depends on the load, and whether it is opened at a certain critical part of the wave. One may open a break switch a dozen times and nothing occur, but, given suitable conditions at the thirteenth time, the effect will be serious. **Theberath** had found that the best way to open an oil break switch was to do it slowly, so as to give the oil a chance to dissipate the arc before getting too much distance between. On opening a switch quickly he had found the contact points burned slightly, as the oil had not had time to get in between the contact points. When the switch was opened slowly the contacts were saved absolutely—there were no indications of any burns. **Poole** pointed out that from experiments he had made with special transformer oil and switch oil, something other than oil must be used as the liquid for breaking arcs on extremely high voltages; he had found that at 28,000 and

34,000 volts the oil is carbonised very rapidly so that black streaks can be seen across it. **Sterling** called to mind a switch at Montreal in which compressed air was used. It not only broke the arc suddenly, but had the advantage of cooling off the contacts, and thereby lessening the volatilisation of the metal feeding the arc. He thought that the switch of the future would be worked on those lines. E. K. S.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

2483. *Keighley Electricity Works.* (Elect. Engin. 28. pp. 366–370, Sept. 13, 1901.)—This station supplies continuous current. It contains two Lancashire boilers 30 feet by 8 feet; two 120-kw. and one 200-kw. dynamo; a battery of 256 cells, giving 85 kw. for 10 hours; and the engine-room, which is 85 feet by 40 feet, contains a 10-ton travelling crane, the boiler-house being 85 feet by 70 feet, and the battery-room 53 feet by 26 feet. Two feeders have been laid, each consisting of three single cables; the conductors of the one set are 0·4, 0·15, and 0·4 square inch in section, and the others are 0·3, 0·1, and 0·3 square inch. W. H. S.

2484. *Los Angeles Transmission Plant.* (Elect. World and Engineer, 37. pp. 1113–1115, 1901.)—The Edison Electric Company of Los Angeles operates a 33,000-volt transmission line 83 miles long. The transmission lines are two three-phase circuits of No. 1 B & S wire on triple petticoat porcelain insulators. The line wires are 18 to 24 inches apart, but in future this distance will be increased to avoid short-circuits from birds. It was found necessary to have at least 10-kw. transformer capacity to satisfactorily test the insulators at 70,000 volts. No fuses are put in the high-tension lines, nor at the power-house, except that the generators are fused to four or five times their capacity. The power-house contains four 750-h.p., 50-cycle, 750-volt three-phase generators, direct-coupled to Pelton wheels operating under 728 feet head. Generators of this type connected to water-wheels do not give sufficient current on short-circuit to endanger their windings. In fogs all the pole-tops become luminous, but the total power lost on the 83 miles is, at such times, less than 500 watts. Wirt lightning arresters are used, and have 48 $\frac{1}{16}$-inch gaps; there is a static discharge continuously between the gaps for about half the distance to ground, the other gaps being silent. Motor generators are strongly preferred to rotary converters for use with frequency as high as 50 cycles. The Siemens "horn" type of high-tension switch is used. A telephone circuit is carried 6 feet below the transmission line, and operates with entire success. [See also Abstract No. 923 (1899).]

E. H. C.-H.

2485. *Isker-Sophia Power Transmission.* **F. C. Perkins.** (Journal of Electricity, S.F. 11. p. 182, July, 1901.)—Sophia is supplied with electrical energy from a turbine plant on the River Isker, 20 km. distant. There are four turbines by Piccard, Pictet and Co., of Geneva, each of 500 h.p. at 400 r.p.m. Regulation is effected by hand, or automatically, as may be desired. The generators are directly connected with flexible insulating couplings, and they are insulated from the earth. The Maschinen-fabrik Oerlikon has provided the electrical plant. The generators are three-phase, of the revolving field type with 16 poles, ∿ 52, capacity 425 h.p. and power-factor of 0·8. The clearance is 5 mm. Six-pole direct-current machines mounted on the alternator shafts are used for excitation. At twelve substations the pressure is transformed from 7,200 volts to 165 volts for the outskirts of the city, whilst the central area is supplied from a main transformer, reducing the pressure to 3,500 volts, which is then transformed at five substations to the working voltage of 165. The street railways are also supplied from the same source. The high-tension line consists of three copper conductors, each 8 mm. in diameter. W. W. H. G.

2486. *High-Tension Three-phase Railway in the Valtelina.* **H. Martin.** (Génie Civil, 39. pp. 101–106, 1901.)—The Italian Southern Railway Company decided last year to adopt electric traction on their Adriatic lines, using accumulators where the traffic is light and a third-rail system where dense. On the 42 km. between Bologna and San Felice, accumulator trains have just been started; each bogie carriage, weighing 45 tons loaded, has two 50-h.p. motors, and three batteries of 94 cells each, and carries 60 people. With the three batteries in series and the motors in parallel, the speed on the level is 75 km. per hour.

The Valtelina lines (from Lecco to Chiavenna, with a branch from Colico to Sondrio) [see also Abstract No. 1877 (1900)] have been equipped with a third rail on the Ganz system, using 3,000 volts, three-phase, at the motors. The district served is essentially a manufacturing one, and there is also a large tourist element. The 60-passenger cars will carry motors to the amount of 300 h.p., and will weigh 50 tons, with 2 tons of luggage. They can draw four ordinary coaches up a 1 per cent. grade at 60 km. per hour, or up steeper grades at 30 km. per hour. Luggage trains will be drawn by 600-h.p. locomotives, weighing 50 tons, capable of pulling 200 tons of trucks up a 2 per cent. grade at 30 km. per hour.

The long distances between the stations minimise the drawbacks of the alternating system in starting and speed regulation. All metal on the cars, including the metal roof, is carefully earthed, and all apparatus is entirely metal-clad. For equal powers transmitted over the same distance, and with the same drop in voltage, the total weight of copper necessary with continuous current at 700 volts is ten times the weight required with 3,000 volts three-phase. Three hundred amperes is about the maximum current which it is practicable to take from a trolley, and 3,000 volts is therefore necessary for sufficient power to operate trains of the usual size. A device is provided to earth the 3,000-volt trolley wire directly its tension falls owing to breakage.

Energy is supplied from a water-power plant at Mortegno on the Sondrio branch, where three 2,000-h.p. turbines are direct-coupled to alternators generating three-phase current at 20,000 volts and a frequency of 15. The transformation to 3,000 volts is effected in nine substations along the lines, whence are fed the two trolley wires, each 8 mm. in diameter, supported by porcelain insulators from brackets or span wires.

Each motor car carries four motors directly, but flexibly, connected to the axles. At normal speed (60 km. per hour), two motors alone are in circuit, receiving direct in their fixed field coils three-phase current at 3,000 volts. The two other motors are only used in starting and stopping and on grades exceeding 1 per cent., when they are connected "in cascade" with the high-tension motors, *i.e.*, the current induced in the armature of the high-tension motor is led into the field of the low-tension motor, whose armature is in turn connected to a liquid resistance. The transformation ratio in the high-tension motor is such that its armature voltage is 300 volts. In cascade, the speed of the train is halved.

The motor cars have bodies 18·10 m. long and 2·70 m. wide, resting on two bogies whose wheel base is 2·5 m., and whose truck is 4·1 m. long, and is supported from the axle-boxes by ordinary plate springs. The pivots and frame for the body are further supported by two groups of three double springs. The bogie pivots are 11·5 m. apart.

The two trolley wires over each track are tapped by a special form of double trolley consisting of two copper rollers separated by an insulating block of wood. The trolley arm is raised into contact by a piston actuated by compressed air. The rollers make contact with carbon brushes connected to flexibles. Each car has a double trolley at each end, *i.e.*, 12 m. apart, so that dead sections (which never exceed 7 m. in length) can always be spanned. If the trolley jumps the wires or otherwise rises above the normal level it automatically opens an air valve which lowers it.

The cables from the trolley bases to the apparatus on the cars are rubber-insulated, supported in cylindrical porcelain insulators placed every 10 cm. inside brass tubes, which are carefully connected metallically to the wheels and the roof, &c., to insure immediate blowing of fuses in case of leakage. From a distribution box in the operator's cabin circuits are taken through fuses and a primary switch to the motors, and to an 8-kw. transformer supplying current to a motor which compresses the air, and lights, heats, and ventilates the car. The primary switch consists of a horizontal iron plate pivoted on a vertical shaft ending in a rack in which engages a pinion worked by a hand crank. Turning this crank raises the plate, which has on its upper side six porcelain-backed metal bolts with steatite heads. These bolts are vertically below six copper sockets sunk in porcelain insulators, three sockets being connected to the motors and three to the collecting apparatus. The bolts enter the sockets with slight pressure, and when withdrawn cause a little rarefaction of the air, which opposes the formation of an arc, which is further prevented by the steatite heads. Reversal of the current to the motors is effected by simple rotation of the lower switch-plate around its vertical axle. A relay in the return circuit to the rails lowers the switch-plate if the current to the motors exceeds the safe limit.

Each bogie truck has a high-tension motor on one axle and a small low-tension motor on the other axle. The large motor will give 150 h.p. at full speed. The armature shafts are hollow, and are threaded over the axles, to which they are connected by springs forming an elastic coupling.

The 3,000-volt current goes only to the main motor fields, and the sole operation which has to be done with it is the closing and opening of the primary switch. All regulation is performed on the low-tension induced current by a two-point controller, putting the motors in cascade or otherwise, and an air valve which regulates the height of liquid in the rheostat. The rheostat consists of a series of small sheets of iron up which an alkaline solution is forced. When the liquid reaches the top, a float operates an air valve, which works a switch short-circuiting the three legs of the armature winding. There are two rheostats per car. All high-tension apparatus is in a locked case, the key to which is inaccessible as long as the trolley is raised.

The air compressor for the whistle, brakes, and controlling gear is worked by a 5-h.p. three-phase motor at 100 volts. An automatic brake is provided, so that when current fails the train is at once pulled up. This will work when an overhead wire is broken or when a section is intentionally made dead to prevent the train passing, thus forming an effectual block system.

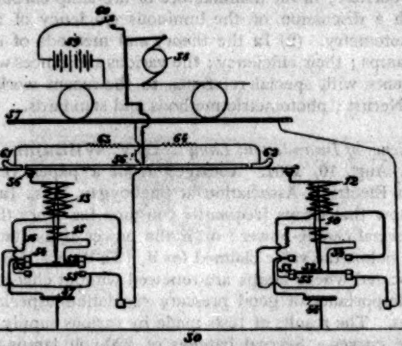
E. H. C.-H.

2487. *Lincoln Power Station, Boston, Mass.* (Eng. Record, 44. pp. 147–151, Aug. 17, 1901.)—The *boiler-room* contains twelve Babcock and Wilcox boilers in batteries of two each. Each boiler is rated at 500 h.p. at a pressure of 200 lbs. per square inch. The feed-water is heated by Green's economisers, after passing through exhaust heaters, and Webster secondary open heaters, placed beneath the stack. It enters the boilers at a temperature of 300°–325° F. Coal is raised to bins above the boilers by a conveyor, and is fired by Roney stokers. The *engine-room* contains two Rice and Sargent vertical compound engines of 4,000 h.p. at 75 r.p.m. with a steam pressure of 160 lbs. Their cylinders are 44 and 88 inches diameter, and 60 inches stroke. The flywheel weighs 120 tons. A third engine is being built by the Westinghouse Company of the same dimensions. Each engine exhausts into an independent Blake jet condenser. Each engine drives directly a 2,700-kw. direct-current generator giving current at 550-600 volts. One is by the General Electric Company, and the other by the Westinghouse Company.

Scale drawings are given of the constructive details of the power-house, of the coal bins, and of the main steam header. G. H. B.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

2488. *Felice, Tosi, and Parboni's Surface-contact System.* **J. Reyval.** (Écl. Électr. 28. pp. 218–219, Aug. 10, 1901.)—The essential elements of this system are:—(1) Electromagnetic switches acting on the principle of the differential arc-lamp regulator, so that the gravity break is supplemented by an electromagnetic pull-off. The break takes place between carbon contacts under heavy wood-tar oil, and each switch is enclosed in a moisture-proof iron case and is permanently connected to the positive main; (2) steel contact plates placed between the rails, each plate being permanently connected to its switch; (3) a contact skate having a short portion at each end insulated from the central part and connected through resistance coils to the motor circuit, the object of this arrangement being to diminish the sparking in the switches; (4) a small storage battery on each car for starting. The arrangements are shown in the accompanying diagram, in which 80 is the main feeder, 57 the rail, and 56 the skate. The system has worked well during a six-months' experimental trial in Rome. G. W. DE T.



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[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

2489. *Signals on the Boston Elevated Railway.* **H. S. Knowlton.** (Street Rly. Journ. 18. pp. 155–159, Sept., 1901.)—This paper describes the various kinds of signals employed. On certain tracks automatic block signals are used, which apply the air-brake if the train runs past a danger signal; the signals are worked automatically by the train entering and leaving the block. G. H. B.

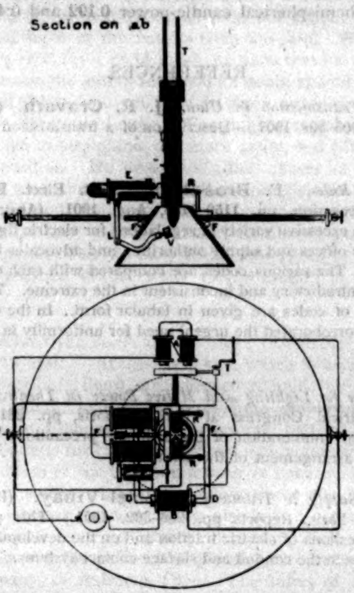
2490. *Testing Electric Automobiles.* **W. A. T. Müller.** (Centralblatt Accumulatoren, 2. pp. 209–211, Aug. 1, 1901.)—In this paper some equations are first deduced giving the connection between the turning moment and the current, using a series motor. An arrangement is then described for starting and stopping a stop-watch at the beginning and end of a measured distance, this being effected by means of an electromagnet in a circuit extending along the track. Currents are passed along this circuit by means of mercury switches formed by indiarubber tubes filled with mercury, over which the vehicle passes. C. K. F.

ELECTRIC LAMPS AND LIGHTING.

2491. *Progress in Electric Lamps.* **A. Blondel.** (International Electrical Congress at Paris, Reports, pp. 210–250, 1901.)—This paper consists of a valuable critical discussion of the difficulties overcome and the progress made, mainly during the last ten years—(1) In knowledge of the phenomena of the electric arc; in the construction of arc lamps, and the methods of supplying them with current; in the manufacture of arc-lamp carbons: the section concludes with a discussion of the luminous efficiency of arc lamps and methods of photometry. (2) In the theory and methods of manufacture of incandescent lamps; their efficiency; the various substances which have been tried for filaments, with special reference to the recent work of Welsbach, Le Roux, and Nernst; photometric methods and standards. G. W. de T.

2492. *Efficiency of Incandescent Lamps.* **G. V. Williams.** (West. Electn. 29. pp. 82–83, Aug. 10, 1901. Abridged from a paper read before the North-Western Electrical Association at Sheboygan, Wis., June 26, 1901.)—Actual tests show that lamps frequently consume far more than their rated power, if of normal candle-power; or, if the power is as stated, the candle-power is much below the value claimed for it. To detect these faults careful testing is advocated where lamps are renewed without charge. Attention is drawn to the importance of good pressure regulation, especially with high-efficiency lamps. The results of tests made by various supply companies are given, with life curves. Several batches of 220-volt lamps were found to have an average life of 750 to 930 hours without losing more than 20 per cent. of their rated candle-power, taking from 4·18 to 4·6 watts per candle. Lamps of lower voltage taking less than 3·5 watts per candle seldom appear to give satisfaction. A. H. A.

2493. *Bremer Arc Lamp.* **F. Laporte.** (Soc. Int. Élect., Bull. 1. pp. 360–370, July, 1901.)—This lamp [see Abstract No. 2117 (1900)] has its two carbons CC equally inclined on each side of a vertical line, and making an angle of 20° to 30° with each other. They are guided by tubes in which they slide, and heavy masses M resting on them ensure their descent. An armature P, whose pressure is regulated by springs R, touches the lateral surface of the two carbons through an opening in the tubes, and acts as a brake, so as to stop their descent. An electromagnet E, when the current passes through it, pulls away this armature, and the carbons slip down. This armature governs at the same time, by means of the jointed levers L, a kind of pallet V, which takes a position at the apex of the angle formed by the two carbons, when the armature P is attracted by E, but is ordinarily kept out of the way by the action of the springs. The object of this pallet is to maintain the ends of the carbons always in the same horizontal plane. A shunt relay A, furnished with a contact I, makes or breaks the current in E, according as the potential difference of the arc is higher or lower than a fixed value. Finally, two differentially wound bobbins B (main and shunt) magnetise a core D with pole pieces F, placed on either side of the arc. The magnetic field thus produced is perpendicular to the plane of the two carbons, and has a direction so as to blow the arc down to the points of the carbons. All these parts are attached to a horizontal plate, which carries a conical reflector and supports the globe. Lighting is effected by the relay A, which sends the current through E and attracts the armature P, allowing the carbons to slip till they touch the pallet V, which is brought under them by the attraction of P to E. The potential difference on the lamp falls below its normal value, and the current through E is cut off by the relay breaking contact. The carbons are locked in their new position by P, and V is rapidly drawn away, striking the arc between the carbons. As the carbons are now very near together, the current is too large, so that the series winding of B prevails, and produces a strong field between the poles F, which blows the arc down in a pronounced curve below the carbons. As the carbons burn away, the arc lengthens and the main current diminishes; this diminishes the field between



the poles F, and the arc takes a less pronounced curve, thus becoming shorter. The carbons used in the lamp are a Siemens, series A, solid 6 mm. for negative, and a special 7 mm. cored carbon for positive. A gramme of this special carbon calcined in the air gives 0·28 gramme of residue composed principally of magnesia, aluminia, and silica. The lamp works at 9 amperes and 43 to 45 volts. Photometric measurements were made by the authors in this lamp, and comparison was made with an ordinary arc lamp, both with and without globes. The figures for the Bremer lamp without globe and with globe are respectively: Potential difference 45·2 and 45·9 volts; current 9·45 and 8·75 amperes; watts 427 and 400; luminus flux (lumens) 13,950 and 8,020; mean spherical candle-power, 1,110 and 638; mean lower hemispherical candle-power 2,220 and 950; watts per spherical candle-power 0·385 and 0·628; watts per lower hemispherical candle-power 0·192 and 0·421. E. C. R.

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2494. *Power Transmission in Utah.* **J. R. Cravath.** (Elect. World and Engineer, 37. pp. 503–508, 1901.)—Description of a transmission over 36½ miles at 16,000 volts. M. O'G.

2495. *Wiring Rules.* **F. Broadbent.** (Inst. Elect. Engin., Journ. 30. pp. 1130–1150; Discussion, pp. 1150–1158, Aug., 1901. (Abstract).)—The author protests against the excessive variety of regulations for electric lighting installations, issued by insurance offices and supply authorities, and advocates their reduction to a uniform standard. The various codes are compared with each other in detail, and are shown to be contradictory and inconsistent in the extreme. The main features of a large number of codes are given in tabular form. In the discussion, several speakers strongly corroborated the urgent need for uniformity in such regulations. A. H. A.

2496. *Electricity for Lighting and Motive Power in Theatres.* **L. Mornat.** (International Electrical Congress at Paris, Reports, pp. 281–286, 1901.)—The paper consists of an enumeration of the ordinary precautions to be observed in wiring and in the arrangement of the circuits. G. W. de T.

2497. *Current Supply to Tramways.* **Postel-Vinay.** (International Electrical Congress at Paris, Reports, pp. 286–302, 1901.)—This paper consists of notes on early suggestions of electric traction and on the development of the trolley, with brief references to the conduit and surface-contact systems. G. W. de T.

2498. *Overhead Line Construction.* **K. B. Thornton.** (Elect. World and Engineer, 38. pp. 61–64, July 13, 1901. Paper read before the Canadian Electrical Convention.)—Particulars are given of the length, size, and life of poles, their treatment and erection; also of cross-arms and insulators. Various methods are described of making dead-ends on a line. The erection of line wire and guys is dealt with briefly, and some figures of wind and other stresses are given. The protection of lines from lightning is discussed at some length. G. H. B.

TELEGRAPHY AND TELEPHONY.

2499. *Dredging for Cables in Deep Sea.* **H. Larose.** (Écl. Électr. 28. pp. 197–206, Aug. 10, 1901.)—The author considers the causes of failure to grapple the cable, which, in the instances quoted, and shown in tabular form, average over 50 per cent. of the attempts. He finds that the failures have been due chiefly to the use of too light a tow-rope, and too short a length of towage. He argues that, to keep the grapnel horizontal, and to permit the teeth to properly embed themselves in the sea bottom, and to drag through it continuously, the length of line paid out should be considerably more than the actual depth of the bottom from the ship. When the latter is proceeding at a slow rate, say 1 or 1½ knots, he finds that for a rope weighing 0·9 kg. per m. in the sea, the length for 1,000 m. depth should be 1,780 m., and for 2,000 m. depth, 2,880 m. line. A table is given showing the proportions to be observed for different depths. For lighter ropes a longer tow is required, as they tend to straighten out more easily, and lift the grapnel out of the horizontal position. He describes other causes of failure, such as jerking the grapnel over the bottom and the entanglement of the tow-rope in the teeth, where, in first paying out, the grapnel happens to stand upright, and he mentions that the "Centipede" and Rouillard's patterns overcome this difficulty. Experience shows that, at the slow speed of the vessel above mentioned, the resistance of the water to the motion of the tow-rope is negligible. E. O. W.

2500. *State Telephone-Exchange at Brussels.* (Elektrotechn. Zeitschr. 22. pp. 751–753, Sept. 12, 1901.)—At this exchange, which is arranged in the first place for 6,000 subscribers, there are complete metallic circuits and, for the most part, underground conductors, the system employed being that of the Western Electric Company with a central battery and glow-lamp signalling. The conduits for the underground conductors are constructed as follows: On the bottom of the trench is a layer of concrete 10 cm. thick, and then a thin layer of cement. Into this, the lowermost row of glazed earthen-tubes is pressed, the remaining rows being also laid in cement. These tubes are 460 mm. long, and have an internal diameter of 80 mm.; they were delivered at Antwerp at the price of 67 pfennig per metre and laid by the H. B. Camp Company, of Aultman, Ohio. The tubes of each conduit are centred by means of a mandrel 750 mm. long. At one end this mandrel bears a disc of indiarubber which fits the inner walls of the tubes fairly tightly and carries forward and pushes out all superfluous cement, dirt, &c. The cost per metre run is about the same as for cement conduits. Diagrams of the connections are given, and details of the method of working. C. K. F.

2501. *Telephone Wires on Power Line Poles.* **T. E. Theberath.** (Journal of Electricity, S.F. 11. pp. 168–170, July, 1901. Paper read before the Pacific Coast Electric Transmission Association, San Jose, June, 1901.)—After giving some examples of defective arrangements, the author gives it as his experience that the spiralling of the power wires is of more importance than the transposition of the telephone wires; and in the 60-mile line from the power-house to Sacramento the telephone wire was carried, without transposition, 5 feet below the three-phase power wires, which were arranged to form two circuits on the points of a hexagon with 2-foot sides, each circuit being given a third of a turn per mile, in opposite directions. With this arrangement any multiple of 3 miles is exactly balanced, and if the distance is known beforehand the spiralling can be arranged to give an integral number of turns. This not being so in this case, the last section, which was not exactly 3 miles in length, was divided into three. In the Bay Counties power line, 142 miles long, the end was left unbalanced, the effect, on account of the great length of the line, being negligible.

The telephone wire on the latter lines is No. 4 stranded aluminium cable for a distance of 80 miles, and three-strand aluminium cable for the rest of the distance. The insulators are of double-petticoat, double-groove glass, on two pins, equidistant from the pole, on a six-pin arm 5 feet below the power wires, which carry current at 40,000 volts connected with earthed neutral. When everything is in order the line is absolutely quiet, but becomes very noisy in the case of an earth on the telephone wires, as this reduces the telephone line to a single wire with an earth return.

G. W. de T.

REFERENCES.

2502. *Wireless Telegraphy between Borkum and Borkum Lightship. German Post Office Report.* **Jentsch.** (Archiv Post Tele. 8. pp. 251–262, 1901.)—This is a description of the work done by wireless telegraphy between the above-mentioned stations during the past year, with notes on difficulties met with and methods of overcoming them. A description of Slaby's system is also given. J. E.-M.

2503. *Wireless Telegraphy between France and Corsica.* **J. Blondin.** (Écl. Électr. 28. pp. 93–98, July 20, 1901.)—A concise description, with diagrams and illustrations, of the installation erected for the French Government by Marconi's International Communication Company. J. E.-M.

2504. *Guarini Automatic Repeater in Wireless Telegraphy.* (Elect. Rev. 48. pp. 871–872, May 24; 966–968, June 7; 1112–1119, June 28; and 49. pp. 43–45, July 12, 1901.)—Description of experiments.

2505. *Telephone Cables.* **W. Blackstone.** (Écl. Électr. 28. pp. 168–178, Aug. 3, 1901.)—These articles appear to be on the same lines as those referred to in Abstract No. 1304 (1901). It gives an account of the methods suggested respectively by Pupin, S. P. Thompson, and Reed for increasing the speed of signalling through cables. R. A.

2506. *Simultaneous Multiplex and Ordinary Telegraphy.* **E. Mercadier.** (Comptes Rendus, 133. pp. 472–474, Sept. 16, 1901.)—This paper describes the success of the system, as applied to the circuit betweeu Paris and Bordeaux, without disturbing existing arrangements, by which thirteen twenty-word telegrams can be exchanged hourly. The Mercadier system was described in Abstracts Nos. 1995 (1899) and 1388 (1900). E. O. W.